DOCUMENT RESUME

ED 311 576 EA 021 347

TITLE	Education, Technology, and the Texas Economy, Volume 1: Economics of Eduction. Policy Research Project Report Number 85.
INSTITUTION	Texas Education Agency, Austin.; Texas Univ., Austin. Lyndon B. Johnson School of Public Affairs.
REPORT NO	ISBN-0-89940-690-4
PUB DATE	88
NOTE	122p.; For related documents, see EA 021 348-349.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Economic Impact; Elementary Secondary Education; *Labor Force; *Labor Force Development; Technical Education; *Technological Advancement
IDENTIFIERS	*Texas

ABSTRACT

Economic internationalization has caused the traditional advantages enjoyed by the Texas and U.S. economies to either disappear or to diminish in importance. Further, technology has allowed natural resources to become less important, while elevating knowledge and skills as the keys to improvements in productivity, living standards, and national power. The development and use of leading edge technology is necessary; a work force with higher-order thinking and communication skills is required. Unless we give greater attention to upgrading the skills and knowledge of those who have already completed school and enact fundamental structural reforms within the current school system, the economic challenges the country will face during the next 10 to 15 years are likely to be unmet. School productivity must be improved to bring almost all students to a level previously reserved for the elite. To help accomplish this, it is particularly important to improve the status, remuneration, and responsibilities of teachers. In addition, decisions must be decentralized to the schools, and highly qualified professionals must be held accountable for measured student achievement. Moreover, many successful interventions depend on changing attitudes and expectations; the elitist myth that educational achievement is due to innate ability rather than hard work must be abandoned. The bibliography contains 122 references. (KM)

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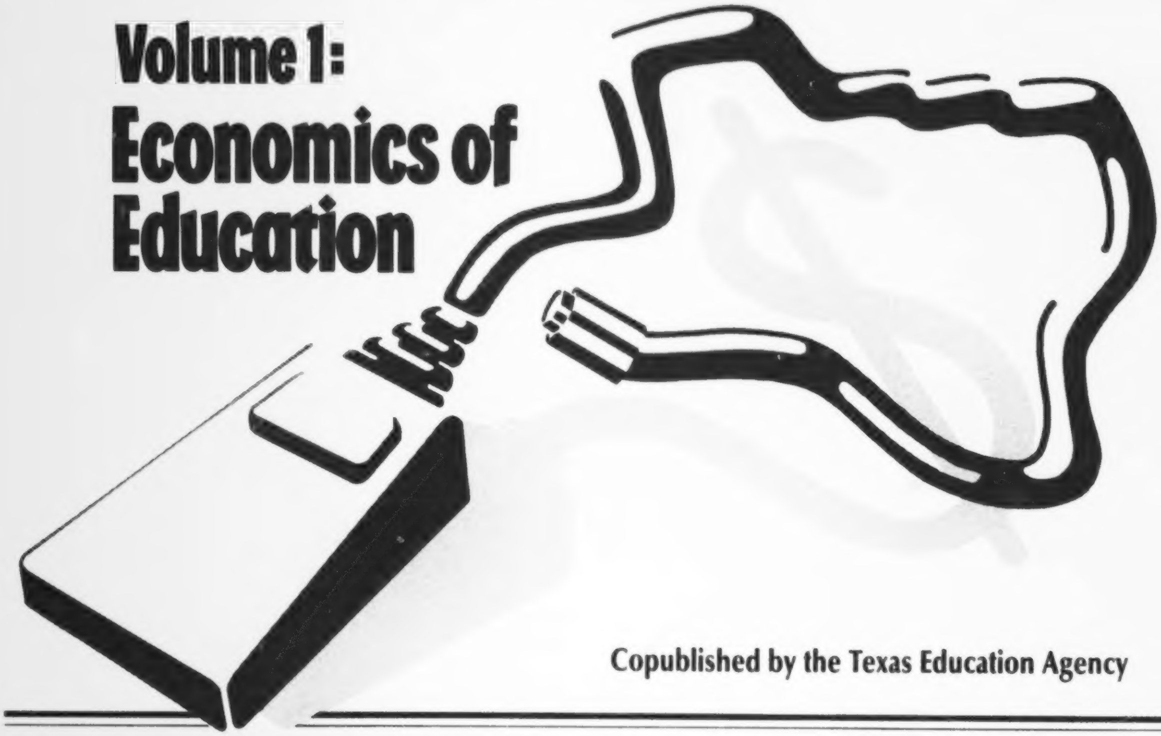

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EA 021 347

Lyndon B. Johnson School of Public Affairs
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Lyndon B. Johnson School of Public Affairs
Policy Research Project Report
Number 85

Education, Technology, and the Texas Economy

Volume 1
Economics of Education

A report by the Policy Research Project on
Education, Technology, and the Texas Economy
Copublished by the Texas Education Agency
1988

Library of Congress Number: 88-51333
ISBN: 0-89940-690-4

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FOREWORD

The Lyndon B. Johnson School of Public Affairs has established interdisciplinary research on policy problems as the core of its educational program. A major part of this program is the nine-month policy research project, in the course of which two or three faculty members direct the research of ten to twenty graduate students of diverse backgrounds on a policy issue of concern to a government agency. This "client orientation" brings the students face to face with administrators, legislators, and other officials active in the policy process, and demonstrates that research in a policy environment demands special talents. It also illuminates the occasional difficulties of relating research findings to the world of political realities.

In the summer of 1987, the Texas Education Agency enlisted the Lyndon B. Johnson School of Public Affairs in such a project and began a joint effort to examine the relationship between public education and the economy in Texas. Professors Ray Marshall, John Gronouski, and Robert Glover and students at the LBJ School worked closely with TEA staff in the Department of Research and Information to examine the relationship between the Texas public schools and the economic future of the state. The result of this joint effort is a series of reports concerning education, technology, and the economy.

The first of these reports, *Economics of Education*, by Professor Ray Marshall, focuses on current economic and demographic trends in Texas and their implications for public education. This report will be followed by two additional papers, addressing the issues of technology and the Texas public schools and vocational education and the Texas economy.

These reports provide an excellent resource for all of those engaged in the public debate surrounding education and the future of Texas. It is the hope of the LBJ School, the State Board of Education, and the Texas Education Agency that this report will enlighten and inform all of those involved in the policy making process.

Finally, it should be noted that neither the Texas Education Agency, the LBJ School, nor The University of Texas at Austin necessarily endorses the views or findings of this study.

WNKirby
W. N. Kirby
Commissioner of Education

Max Sherman
Max Sherman
Dean

ACKNOWLEDGEMENTS

This study was prepared as one of a series of three reports resulting from a policy research project at the Lyndon B. Johnson School of Public Affairs, entitled *Education, Technology and the Texas Economy*. The project was funded by the Texas Education Agency and the State Board of Education. But more than funding was provided. We wish to thank members of the Texas State Board of Education and the Texas Education Agency who worked with us on this project by sharing information, by making presentations to our group, or by providing guidance, comments, and suggestions on initial drafts of our reports. In this regard, we want to give special thanks to the following individuals: Thomas E. Anderson, Susan Barnes, Victoria Bergin, Dan Bristow, Keith Cruse, Madeleine Draeger, Geoff Fletcher, W.N. Kirby, Cynthia Levinson, Criss Cloudt McCuller, Lynn M. Moak, Robert Patterson, Rob Scott, Richard Swain, Marvin Veselka, and Joe Wisnoski.

We especially appreciate the efforts of Debra Haas, who served as our project officer at the Texas Education Agency and provided substantial help on all stages of the project from original design through completion.

We also wish to thank several individuals who took time from their busy schedules to travel to Austin and meet with us on various aspects of this fascinating subject, including Roy Amara, president, Institute for the Future; Anthony Carnevale, vice president and chief economist, American Society for Training and Development; Francis Dummer Fisher, consultant to the PERSEUS project of Boston University and Harvard; Larry Jenkins, chairman of the Texas Select Committee on Education; Henry Kelly, Office of Technology Assessment, U.S. Congress; Robert Taggart, president, Remediation and Training Institute; and Marc Tucker, president of the National Center on Education and the Economy.

Literally hundreds of people, both in Texas and elsewhere, were consulted or interviewed for this project. Although we cannot name them all here, we wish to thank them for their contributions.

Thanks are also due to Jeanette Paxson and Maria Martinez of the LBJ School Publications Office for their expeditious assistance with editing and production of the publications, and to Cheryl McVay who demonstrated remarkable patience in retyping numerous versions of this report.

Finally, we want to remind the reader that any remaining errors in the reports are the responsibility solely of the authors.

EXECUTIVE SUMMARY

This paper provides the background to the 1987-88 Policy Research Project on *Education, Technology, and the Texas Economy*. It is based on three major assumptions: (1) that information technology can improve the administration of schools and the efficiency of learning by students; (2) that the effective use of technology in schools requires an understanding of the broad economic, technological, and demographic trends affecting the U.S., Texas, and world economies; and (3) that there is a positive relationship between education or schooling on the one hand and productivity, economic growth, and personal incomes on the other.

One of the main forces affecting the Texas and U.S. economies has been the rapid internationalization of economic activity. Internationalization interacts with changes in technology to cause some fundamental shifts in the basic structure of the economy from an emphasis on the mass production of goods mainly for domestic markets to an internationalized information economy where over 70 percent of all goods are in direct competition with products made in other countries.

The basic organizing principle of the mass production system was economies of scale, whereby productivity was improved by using relatively fixed physical assets (plant, land, and equipment) to provide large, standardized outputs. The large capital requirements for this system minimized technological changes within the system and caused the emergence of oligopoly and other noncompetitive systems.

The "scientific" management processes developed for mass production systems assumed a work force bifurcated between elite managerial, professional, and technical workers and masses of routine "cog" workers. The elites collected and analyzed data, solved problems, made plans and designs, and gave orders. Most workers did repetitive "cog" work and took orders. This management system was intentionally designed to minimize the need for workers to think or deal with change.

In addition to determining what students needed to know, scientific management was applied to organization and operation of the schools. Teachers (mainly young women) did the "cog" work, students were the "products," and the "elite" work in the schools was done by principals, superintendents, and university professors, who were mainly men. An elite education system produced managerial, professional, and technical workers.

The economic system was able to achieve remarkable progress because of the economies of scale, mass education (literacy, numeracy, and discipline), improved health, and the shift of resources out of low-productivity areas like agriculture into standardized manufacturing. The system was sustained after the 1930s by government policies to stimulate aggregate demand to compensate for the difference between the enormous output of standardized products and the limited ability of farmers and workers to purchase that output.

Internationalization and technological change made mass production and the systems associated with it much less viable. The new basic organizing principle is no longer mass production but *competitiveness*. Intensified international competition made it very difficult for oligopolies to operate, and require much greater attention to productivity and quality. The system also places a premium on flexibility and change instead of

stability. The new information technology makes it possible for products to be more *customized* rather than standardized. In fact, the more competitive international information system is responsive mainly to customers, while the mass production system was controlled more by large oligopolistic or regulated producers.

The implications of the internationalized information system for education depends basically on what kind of country or state policy makers wish to have. Competition can either be achieved by reducing prices and incomes, by improving quality and productivity, or some combination of these. If we want a world-class economy that has the ability to maintain and improve incomes and national power, we must develop and use leading-edge technology. Standardized technology is a commodity that will seek the lowest-cost human and physical resources. In an internationalized market, the prices of commodities will tend to be standardized. The prices of products differentiated by quality and productivity will include rents that make it possible for people to have higher incomes.

Technology thus becomes a key determinant of the ability to maintain and improve incomes and national power. But technology is not just *equipment*; technology is the way we do things. It is therefore skills, knowledge, and creativity embodied in people, equipment, organizations, and institutions. There is, in addition, a synergistic relationship between people and technology. The extent to which skills, knowledge, and creativity are embodied in technology depends heavily on the degree of standardization. Mass production technology was relatively static, so most workers need only basic skills. Innovations tended to take place outside the workplace. Information technology is more dynamic. Innovations therefore tend to take place incrementally and at work. The technology also tends to be more tacit and idiosyncratic. This means that those who use that technology in their daily work must be involved in its development. The more competitive workplace is characterized by change and unexpected developments. Workers must consequently have analytical and problem solving skills in order to detect problems early, because the costs of start up defects cannot be amortized over large product runs. Instead of dealing with routine processes, workers must be able to deal with change, manage responsibility, solve problems, analyze data, establish patterns in confusing and random events, and deal with ambiguity. Flexible production systems also give workers more *discretion* for controlling the system. And, since components of production systems must be highly coordinated, workers must be able to communicate with a high degree of precision.

There is a debate among economists over whether the new technology will displace workers and require fewer skills and less education or whether it will create jobs and require higher levels of education and skill. After examining the evidence on both sides of this issue, I conclude that if we want to be world class, we will adopt management systems and economic policies that require more and different kinds of skills and knowledge. Even what are now considered to be relatively low-wage occupations will require more education. Information technology is ubiquitous and therefore will pervade the services as well as goods production. In the competitive international information society, uneducated people are likely to have great difficulty supporting themselves through productive work. In short, in a world-class system most workers must think for a living; they must have the kinds of education formerly available mainly to the elite.

Basic demographic and labor market trends will affect education and employment. Among the most important of these is the increased labor force participation of women, which has transformed the family, one of our most important learning systems, and the rapid growth in minorities, especially Hispanics. The dramatic increase in female-headed households and the feminization of poverty have caused many young children to have serious learning and intellectual deficiencies by the time they enter the school system, the lack of adequate health care and nutrition for young children can cause cumulative learning problems for young people throughout their school years. The increased proportion of minorities, most of whom have serious education deficiencies and limited access to quality learning systems, is a particularly serious problem. It is particularly noteworthy that children from low-income families tend to lose much of their educational gains during the summer months. Other family-related education problems include high dropout rates of over 25 percent overall and 50 percent or more for minorities in high-risk areas. There are particularly serious problems for that half of the 16-to-24-year-old population that is not college bound.

Fortunately, many people escape from poverty, mainly through education and effective interventions to overcome the consequences of health and education deficiencies. Particularly noteworthy are the Women, Infants, and Children (WIC) program; Head Start; the Comprehensive Competencies Program (CCP) and public employment and training programs. These activities not only are effective in dealing with the education problems of the disadvantaged, but also yield high individual, fiscal, and social dividends.

Most of this paper analyzes the evidence with respect to the relationships between education, productivity, income, and employment. The facts are not in dispute: there are positive relationships between educational achievement (not necessarily schooling) and income and employment. What is disputed is the causal relationship between education, schooling, productivity, and incomes.

In addressing this problem it is important to distinguish between schooling and education. As noted, much learning takes place in the family. Other learning systems include peer associations, community organizations, and the mass media, especially television. Econometric evidence suggests that only about 15 percent of the education related to lifetime income is attributable to schooling; the rest comes from on-the-job learning systems. Schooling is pivotal, however, because it determines who gets the best on-the-job learning opportunities as well as who has the best ability to learn on the job.

The following data from the American Society for Training and Development (ASTD) provide the most comprehensive information on the *size* of the learning enterprise in the U.S. in the middle of the 1980s:

		Expenditures (billions)
1.	Elementary and secondary schools	$144
2.	Post secondary	94
3.	Employee informal training	180
4.	Employee formal training	30
5.	Government training	5
		$453

Source: Anthony Patrick Carnevale, "The Learning Enterprise," *Training and Development Journal*, January 1986, p. 18.

Corporate training systems have thus become very important, and for a number of reasons are likely to become even more important in the future. First, corporate systems yield returns averaging about 11 percent overall, ranging from 5 percent for informal, on-the-job training mainly for blue-collar workers to 29 percent for in-house corporate learning systems mainly for white male managerial and technical workers. Unfortunately, however, most corporate training is by large companies while most of the job growth is in smaller companies.

Besides high yields on these investments, corporations support on-the-job learning systems in order to attract and retain the kinds of workers they need to be competitive, to provide remedial education to applicants who cannot meet their basic skills requirements, and to provide education that either cannot be provided as efficiently or is not provided at all by regular schools.

Several kinds of evidence can be adduced to demonstrate the connection between education and productivity. The first and most important is logic. As Theodore Schultz and others have demonstrated, people are the active agents of production. Educated, healthy, motivated people are almost unlimited assets. They know how to solve problems and take advantage of opportunities. Almost all improvements in productivity come about because of the substitution of knowledge for physical resources, as illustrated by the agricultural example in which, despite no additions to physical resources since 1925, output has increased several fold. Educated people also are likely to be more creative and therefore to introduce new products and processes. Most important, educated people are able to develop and use new technology more effectively than those with less education.

Secondly, numerous studies have established the connections between education and various outcomes:

1. Educational achievement, as measured by standardized tests (not years of schooling), is directly related to such social pathologies as dropouts, crime, teenage parenting, unemployment, and income.

2. Numerous studies have found that almost all improvements in productivity are associated with improvements in knowledge, skills, and technology.

3. The World Bank has undertaken a number of studies to abstract from markets by relating educational achievement to physical output. These studies have found strong positive relationships.

4. Substantial econometric evidence shows that the returns to investment in education are higher than the returns to physical capital.

None of these results necessarily mean that *schools* are good investments. Indeed, early production function studies concluded that schools had very little impact on educational achievement. These early studies explained differentials in education achievement largely in terms of family backgrounds, not the characteristics of schools. And, despite higher expenditures per student and rising teachers' salaries, scores on standardized tests have declined and international comparisons on math and science tests usually ranked American students very low, even behind some Third World countries.

Later, more sophisticated studies produced more positive findings. General quantitative studies found some schools outperformed others even when family backgrounds were controlled for but could not explain what caused their superior performance. Numerous case studies of specific schools found that effective schools usually have strong leadership and positive expectations for their students, emphasize the basic skills, maintain orderly atmospheres, and have frequent monitoring and feedback between students and teachers. Unfortunately, despite their common-sense appeal, these case studies had several limitations. They could not be generalized, did not show how the characteristics of effective schools improved learning, and did not adequately control for family income.

All of the studies that have sought to detect positive causal relationships between schooling, educational achievement, productivity and incomes had many technical problems, but the preponderance of evidence suggests several conclusions:

1. Education can greatly improve industrial and social economic performance.

2. School reforms are necessary, but not sufficient, for a world-class economy. Reforms will require the schools to go through some of the same processes as companies: decisions must be decentralized more to teachers, whose education and work situations must be greatly improved; schools must develop better success criteria; and school systems must be held accountable for meeting those criteria.

3. Econometric studies using production function approaches that found positive relationships between total outcomes and expenditures but could not find strong relationships between outcomes and individual variables can be explained by participative management assumptions: good teachers with adequate resources can diagnose students' learning problems, deal with unexpected developments, and relate to the tacit and idiosyncratic developments in each learning situation.

Chapter 1

INTRODUCTION

This report provides the background for the 1987-88 Policy Research Project (PRP) on *Education, Technology, and the Texas Economy.*[1] Its main objective is to outline some of the broad trends and forces affecting the U.S. and Texas economies with emphasis on technology and the implications of these trends and forces for education and learning systems. This background paper also reviews the evidence with respect to the relationships between education (attainment of skills and knowledge), schooling (amount of time spent in school), human capital formation, technology, and individual and national economic performance. The purpose of the PRP is to relate these issues more specifically to Texas.

The basic questions explored in this background report include:

1. What are the main economic trends and forces affecting the American and Texas economies and what are their implications for education in Texas?

2. What are the effects of technology on education--i.e., in terms of (1) what workers will need to know; (2) how they learn; and (3) what technology can do to improve the productivity of public schools?

3. What are the main demographic and labor market trends? What are the implications of these trends for education?

4. What is the evidence with respect to the importance of education for (1) personal incomes, (2) economic growth, (3) productivity, and (4) economic competitiveness?

5. What do we know about the effects of different factors (i.e., class size; expenditure per student; and teachers' salaries, experience, education and skills) on the performance of public schools?

6. What do we know about the effectiveness of different efforts to improve the productivity of schools?

Educational policy makers must consider the context within which economic, social and political forces operate. The following chapter outlines some of the main forces at work, with emphasis on their implications for learning systems.

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[1] There are two volumes for this Policy Research Project in addition to this background volume. The titles of the other volumes are *Can Technology Help Texas Public Schools?* and *Vocational Education.*

Chapter 2

TRENDS AND FORCES

Education policymakers must consider the context within which economic, social and political forces operate. The following section outlines some of the main forces at work, with an emphasis on their implications for learning systems.

The trends and forces affecting the U.S. and Texas economies and work forces can be divided into two classes--the universal imperatives and those specific to the United States and Texas. The universals are the growing interdependence of world economies and technological change, especially information technology and certain broad demographic and labor market forces.

INTERNATIONALIZATION

Internationalization means that the U.S. economy is being drawn increasingly into the global economy. The main measures of this growing interdependence are the proportion of GNP entering international trade--about 9 percent in 1950 and 25 percent by the end of the 1970s. However, this measure is deceptive because most international trade is in *goods* and over 70 percent of all the goods produced in the U.S. are in direct competition with goods produced abroad.

A major instrument of internationalization has been the multinational corporation (MNC), whose role in the economy has increased the *mobility and dispersion of capital* through rapid investment and disinvestment in plant and equipment and the movement of jobs around the world. This has been made possible by both advances in communications technology and transportation, and by business strategies that allow the MNCs to seek global markets, low wages, and tax breaks and subsidies from other countries.[2] Increasingly, it is becoming harder to identify the origin of any given product, with the use of "outsourcing" to foreign affiliates, coproduction agreements with foreign firms, and investment in this country by foreign companies. Is there such a thing as an "American car," given the importation of components and cars, joint ventures between foreign companies and American firms, and American investment in foreign automobile companies?[3]

Some American MNCs have adopted "offshore" strategies in which large proportions of their production are taking place overseas. In 1985, Lester Thurow told the American Economic Association:

> In a very real sense, there are no private American firms. There are firms legally headquartered in America but they locate their research and development, office or production facilities anywhere in the world.

---

[2] See Raymond Vernon, "The Spread of Multinational Enterprises: Implications for U.S. Policy," paper prepared for the Joint Economic Committee, January 1986.

[3] For instance, GM's partial ownership of Isuzu and coproduction agreement with Toyota and a Ford-Mazda partnership.

> Per se they have no direct company interest in the success or failure of the U.S. economy. They have only a direct interest in their own success and failure. Often it is cheaper for an American based company to simply move production or engineering abroad than it is for it to make its American operations competitive. Yet foreign production is not a solution to American growth problems even if it is a solution to the competitive problem of American based companies.[4]

Although the competitiveness of American firms measured by the share of world markets captured by U. S. companies operating domestically has declined, the share of their overseas affiliates has increased markedly.[5]

Internationalization and the growth of MNCs have a number of implications for U.S. economic, labor market, and education policies. As with other economic trends, internationalization has advantages and disadvantages. The main advantages are generally higher standards of living because of the gains of international specialization and the transfer of technologies and institutions between countries. The main disadvantages are that we lose control of our own affairs and many of our accepted or well-established institutions and policies are disrupted. The main negatives for labor markets are the displacement of workers because of a more dynamic economy and the fact that a more competitive international economic environment makes it more difficult for a high wage country like the U.S. to maintain or improve real wages. The U.S. and other governments have likewise become more vulnerable to the MNCs and other international institutions, decisions, and forces over which we have little control.

Traditional economic policies have been altered by internationalization. The macroeconomic policies that contributed to the longest period of sustained prosperity in our history between the 1930s and 1965 lost some of their effectiveness by the 1970s. Efforts to stimulate the economy, for example, are less effective because of international leakages (imports, immigration) and efforts to reduce inflationary pressures by slowing economic growth and increasing unemployment have much greater international implications, which boomerang back to the U.S. For example, monetarist U.S. policies combined with unprecedented federal budget deficits in the 1980s produced unusually high real interest rates and an overvalued dollar, which disrupted international markets and caused U.S. exports to be more expensive and imports to be cheaper, contributing to mounting trade deficits and very quickly transforming the United States from a net creditor to a net debtor nation. The main implication of internationalization for employment policy is that we are no longer able to reduce unemployment by national macroeconomic policies alone and our efforts to keep inflation under control by traditional means (i.e., deliberately slowing economic growth) are much more costly in terms of unemployment and lost output.

Internationalization also greatly changes the economics of the firm (or microeconomic policies). Not only has internationalization caused companies to adopt global strategies, but U.S. companies also have been forced to revamp their internal management and pricing policies. Oligopolies, which dominated America's basic industries before the 1970s, attempt to maintain prices and lay off workers during recessions. Changes in demand are therefore absorbed by output and employment and not by wages and prices. Companies in other countries, especially in Japan, have developed pricing policies that make oligopoly obsolete. These policies maintain employment and output and change prices and labor compensation. These policies obviously make it possible for foreign competitors to gain market share from oligopolies in downturns (when competitors reduce prices and hold output) and in upturns (when competitors have the capacity to take advantage of increased demand). Flexible labor compensation is achieved through a bonus system that accounts for about a third of the Japanese workers' income. Bonuses depend on company performance. Obviously, it is much easier not to pay a bonus when sales fall off than it is to cut wages. The firms' adaptability also makes it possible for the entire economy to more easily adjust to change, greatly enhancing the effectiveness of economic policies to increase employment or stabilize prices. The Swedes and Austrians, by contrast, have elected to maintain full employment through flexibility in international trade and labor markets. In essence, they have adopted policies that shift economic activity to high-productivity industries and let wages and prices adjust to competitive levels in the international trade sector. The Swedes also achieve domestic labor market flexibility through well-educated workers and large-scale active labor market policies to better match workers and jobs through training, relocation, and labor market information systems.

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[4] Lester C. Thurow, "Sustained Economic Growth," paper presented at the American Economic Association meetings, December 1985, p. 14.

[5] Robert E. Lipsey and Irving B. Kravis, "The Competitive Position of U.S. Manufacturing Firms," *Banco Nazionale del Lavoro Quarterly Review*, June 1985, pp. 127-154.

International competition puts a premium on quality, productivity, and flexibility, all of which have important implications for human resource development and labor market policies. Traditional American management and industrial relations systems introduced inflexibility by fragmenting jobs and creating adversarial relations between labor and management, thus making it very difficult to achieve internal flexibility. These traditional labor-management relationships, inflexible work rules, and fixed contractual provisions led to rigidities, lower productivity, and poor quality. Indeed, a major problem for American companies, contributing greatly to their long-run loss of international competitiveness, has been their inadequate attention to quality. Too often quality control meant *detecting* defects by managers and inspectors rather than *preventing* them by everyone, especially frontline workers.

The traditional American education system reflected these microeconomic conditions. Scientific management, for example, put a premium on workers who did little thinking for themselves and who were conditioned by various learning systems, including the schools, to perform routine tasks to memorize rather than to analyze and to obey authority rather than to take charge or participate in decisions. Competitiveness in the internationalized information world requires people who can learn to deal with change, diversity, and ambiguity. To produce people with these characteristics, in turn, requires very different learning systems. If we want to have a world-class economy, we can no longer afford to have an elite education system for a few--we have to give all people access to the kind of education previously reserved for the elite.

Internationalization includes several specific implications for labor market policy. The U.S. is a high-wage country, making it difficult to compete through wages alone. Unless we pay greater attention to other ways to compete, American real wages will decline, as they have since the 1970s. Competing at higher wages puts a premium on technological innovation and better management systems. If we lose these advantages, we compete according to wages. We have no clear management advantages. In a broader sense, management systems are part of technology. One of the great innovations of the post-World War II era was the realization that management systems, including worker training and education, could be learned and transferred like equipment. Our basic choice is thus very clear: we can compete by lowering our standard of living or we can become more productive and give greater attention to quality and flexibility.

Unfortunately, we are losing our international competitiveness for a variety of reasons, some good and some bad. The good reasons relate to the inevitable economic development of other countries, which is mutually beneficial--they produce better, lower-cost products and provide growing markets for American exports. The negative causes of our competitiveness problems are poor national economic policies (confused trade policy, erratic macroeconomic policy, ideological decisionmaking and therefore unrealistic and unworkable policies) and obsolete management and industrial relations systems.[6] The most important measures of the loss of competitiveness by U.S. firms are declining profits on the U.S. operations of "American" companies, declining market share in high-tech as well as smokestack industries, declining real wages, a growing trade deficit (even in high tech industries), and a long-run increase in unemployment (figures 1 and 2).

TECHNOLOGY

As noted, technology, a major concern of this PRP, is another important universal imperative. To some technology means only machinery or equipment, but this definition is far too narrow. Technology really means the way to do things, or more precisely, the use of knowledge, tools and skills to solve practical problems and extend human capabilities. In a fundamental sense, technology is ideas and knowledge embodied in people, processes, products, management systems, organizational forms, and structures as well as in machinery. Thus, technological innovation and processes are learning systems, though ordinarily taking place outside of school. It is therefore

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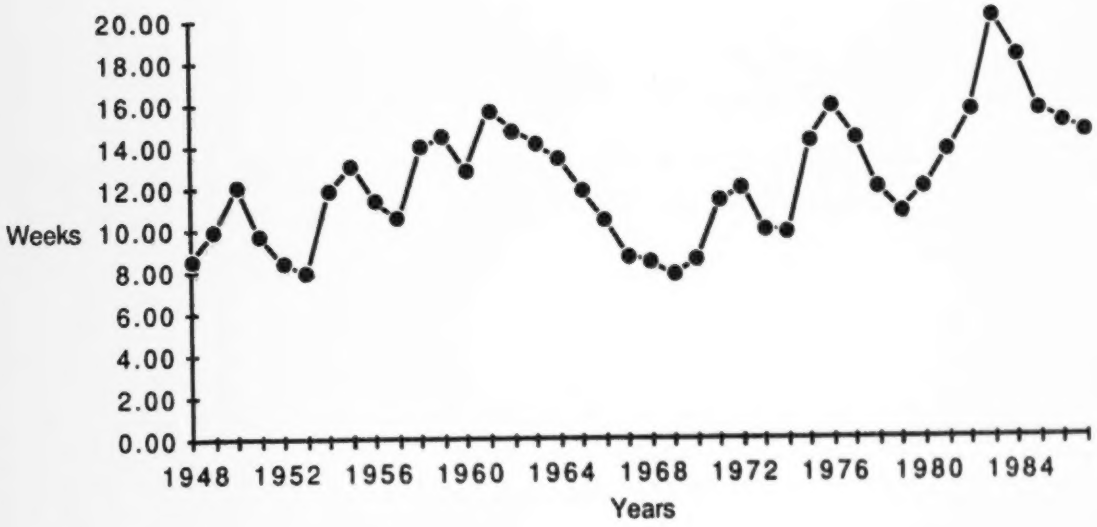
[6] A good illustration of the importance of a management system for competitiveness is afforded by the New United Motor Manufacturing Inc. (NUMMI) at Fremont, California. General Motors had closed this facility during the early 1980s because they could not make it competitive with that company's traditional authoritarian management and adversarial labor relations systems. Toyota reopened this facility with essentially the same technology, workers, and union, but with a more participative, egalitarian management system that stressed the consolidation of hundreds of job classifications into three: production, support (management!), and maintenance worker; elimination of the elitist trappings typical of American management (private offices, parking spaces, dining rooms and pay systems); the elimination of layers of manageers, supervisors and inspectors--making workers more responsible for quality control and production decisions; greater employment (not *job* security); and a bonus system whereby part of a worker's pay is determined by overall company performance. The upshot of all of this is that in 1988 NUMMI was one of the most productive automobile plants in the world--much more productive than GM's more highly automated plants in Michigan, which retained most of the characteristics of the traditional authoritarian management system.

Figure 1

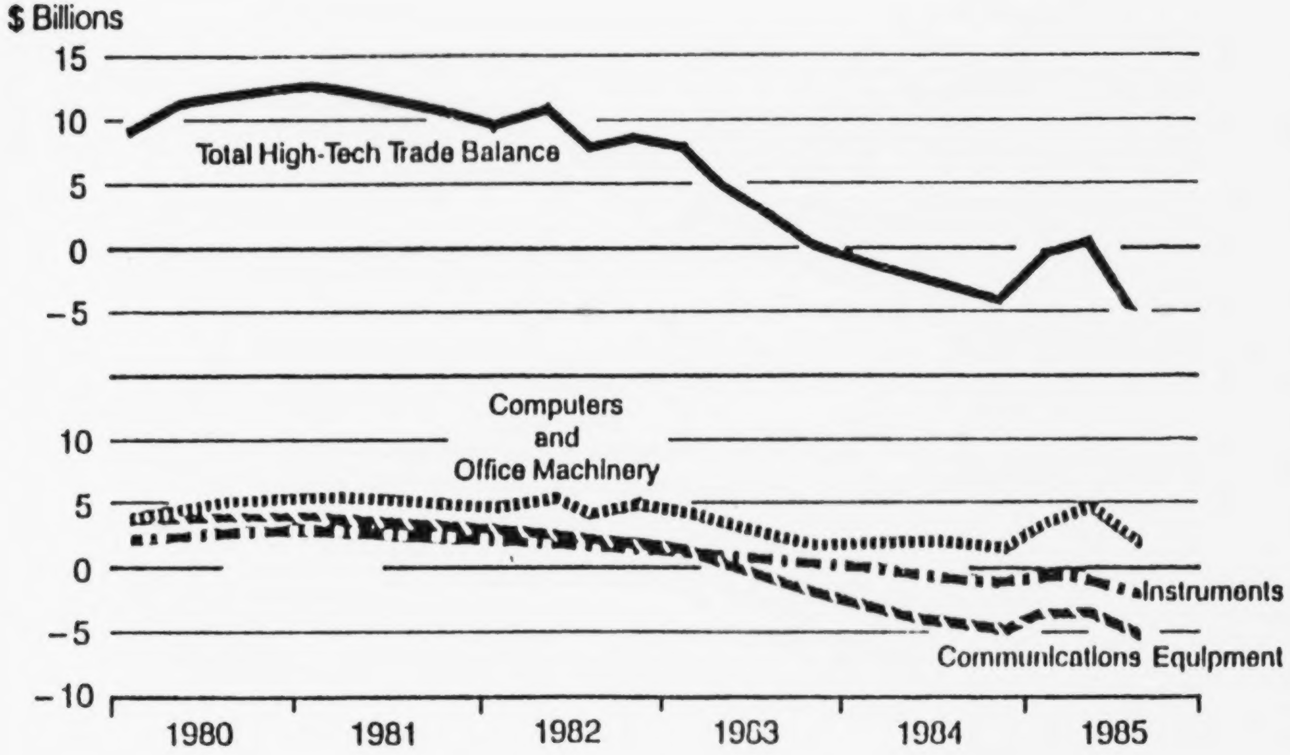
Average Duration of Unemployment
from 1948 to 1987



Source: *Economic Report of the President*, February 1988, p. 294.

Figure 2

A Breakdown of the High-Tech Trade Balance



Source: Merchandise trade by ends-use category, census-based tabulation of U.S. transactions. Bureau of Economic Analysis, Morgan Stanley Economic Research Department.

important to distinguish schooling from education or learning systems. Education is a process--its outcomes are knowledge and skill. Technological innovation also is a process that embodies skills and knowledge in products and systems as well as in people and organizations. It is a serious intellectual mistake to view technology as a noun (physical thing) instead of as a verb (process). Human capital refers to education, and health and child care--or the investment of knowledge, skills and physical capacities in people.

In order to understand the relationship between technological innovation and skill requirements, it is necessary to recognize the stages in the development of most technologies. We shall argue, in addition, that an understanding of these stages is essential to the effective introduction of new technologies into schools.

The *mature (standardized) stage* is characterized by small innovations that can be readily emulated by relatively unskilled labor. Most of the accumulated skill and knowledge has been embodied in the technology (equipment plus organization)--additional skills embodied become relatively minor and easily copied. They therefore cannot be the source of "rents" or above-market incomes. However, radical technological changes create what Joseph Schumpeter called "creative destruction"--they alter the terms of competition in mature industries by upsetting established production processes and market preferences. As Abernathy et al., argue:

> What is truly important about innovation. . .is the extent to which it changes an industry's basis of competition at the same time that it disrupts established production competence, marketing and distribution systems, capital equipment, organizational structures, and the skills of both managers and workers.[7]

Abernathy et al., identify four phases in the development of technology:

1. The *architectural phase*--those epochal innovations whose effect is to create entirely new design concepts and, more important, the production systems and markets to accommodate them."[8] These "changes tend to occur early on, address fundamental characteristics of product and process, and establish design hierarchies that set the agenda for later developments."[9]

2. The *regular phase* occurs "once the basic architecture of a product has been established and its market linkages have begun to crystallize. Technical changes of a regular sort tend to refine and extend established designs in both product and process and to strengthen established market linkages. These incremental innovations are, of course, much less dramatic than their architectural counterparts, but their cumulative impact may be every bit as substantial."[10]

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[7] William J. Abernathy, Kim B. Clark, and Alan M. Kantrow, *Industrial Renaissance: Producing a Competitive Future for America* (New York: Basic Books, 1983), p. 109.

[8] Ibid., p. 110.

[9] Ibid., pp. 110-111.

[10] Ibid., p. 111.

3. The *market niche variability phase* occurs after the processes of standardization and specialization, which occur during the regular phase. This represents "the progressive embodiment of human skills in machines, substantial changes in the nature of the work, and the increasing rigidity of the whole production system. In one sense, of course, regular phase activity may spell competitive vulnerability, for competence that is embodied in capital equipment can be easily transferred. It may also, however, yield an advanced ability to offer greater product variety--an ability that we think of as 'market niche variability.'"[11] In other words, as the technology becomes standardized, it has the ability to achieve a broad range of products from a given design--as was possible, for example, with the application of piston engines to a variety of commercial aircraft after World War II.

4. The *revolutionary phase* comes when "regular and niche creation innovation are not enough to create a more permanent competitive vitality. . .When new technology develops or preferences change, firms will lose competitive position unless they are willing and able to apply substantially new design concepts to their established markets. . .Applying new technology to existing markets is. . .the essential feature of. . .'the revolutionary phase of innovation'. . ."[12]

Clearly, the skills required of the work force are greater as technology progresses through these stages. Much more creativity, problem solving, and experimental skills are required during the revolutionary and architectural stages than when maturity is reached and most of the accumulated skill and knowledge has been embodied in the technology and can be easily copied. A major argument of this report is that to be a high-income state, Texas has to have more of its work force involved in the "leading edge" stages before technology is standardized. Once the mature stage is reached, it is easier for the technology to be exported to low-wage places in other countries.

We have argued that the loss of technological advantage implies competing according to *wages*, which implies a declining standard of living for most people in a high-wage country like the United States. In economic terms, technological change makes it possible for workers, managers and owners to share scarcity "rents"--i.e., if technology is not *standardized* in such a way that it can be readily transferred to other countries. Standardized technology is a commodity whose price is set by demand and supply; unique technologies are not commodities--they command rents and therefore make it possible to maintain higher incomes than the world average.

In fact, the prices (wages) for standardized products and workers are likely to be set in low-wage countries with high population and labor force growth rates. The populations of industrial countries are stagnant while those of the developing countries are increasing rapidly. Indeed, the developing countries will experience *all* of the world's net growth of young adults for the next 25 years; the number and percentage of young adults aged 20 to 40 will actually decline for the industrialized countries, from 366 million to 352 million. The increase in the less developed countries (LDCs) in this critical age group will be from 1471 million to 2026 million.[13] Simultaneously, the demand for workers in the developing countries will not increase as fast as the supply, creating great pressure on wages and generating strong emigration pressures in those countries. At least 500 million new jobs have to be created in these countries by 2005 to prevent joblessness from rising above 40-50 percent, where it was in the mid-1980s.[14]

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[11] Ibid., p. 112.

[12] Ibid., p. 113.

Fortunately, both human capital and competitiveness conditions are such that in many areas technology and the quality of work forces will make it possible for wages to be above world market levels. So far, the lowest wage LDCs have not been very competitive because of the quality of their work forces and the growing skill requirements for the most advanced technology and the fact that manufacturing processes are becoming much less labor intensive and more knowledge and information intensive. What is happening is not so much the substitution of physical capital for labor but the substitution of information for labor and capital. This means, of course, that both the resource and labor-output ratios are declining--i.e., less labor and resources are required for increased production--a fact with enormous implications for commodity producers and for workers. What has happened, of course, is that the combined effects of internationalization and technological change have greatly weakened some linkages that previously were very tight. We have noted that internationalization has weakened the Keynesian linkage between government spending in a country to increase consumption and the consequent increase in investment. For example, after the 1981 tax cuts, increased consumption in the United States stimulated investment in the manufacture of producers' goods in other countries more than it did in the United States because over 90 percent of the increased demand for capital equipment (and a large part of the increased demand for consumers' goods) came from imports. Moreover, the internationalization of financial markets has weakened the already loose connections between financial markets and the markets for goods and services; indeed, the amount of liquidity in international markets is 10 to 25 times the amount needed to finance the sale of goods and services. Similarly, technological changes that substitute information for labor, raw materials, and physical capital have weakened the relationships between commodities, employment and output--requiring more economic growth to maintain given levels of employment and commodity outputs. These developments also mean that wages are becoming *less* important in the production of some products and that a premium attaches to quality of the work force, an understanding that has been acted on strongly by the leaders of resource-poor countries like Germany, Japan, and the newly-industrializing countries (NICs) in Southeast Asia. The leaders of these countries have made truly monumental changes in education because they realize that educated people are necessary for the rapid assimilation of technology.

Technology also has important implications for public schools. Many believe it can be used to improve the efficiency of learning as well as to influence the knowledge that students will need to know and the skills they will need to have. It also is assumed that technology can change the delivery of educational services to make them more accurate, interesting, accessible, and targeted. Many of the lessons learned about the introduction of technology in private enterprises probably are applicable to schools. As we shall see, economists have attempted to apply the same techniques of economic analysis--the concept of the production functions--to schools as to profit-making enterprises, with the same misleading results.

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[13] Paul Demeny, "The World Demographic Situation," in *World Population and U.S. Policy*, ed. John Menken (New York: N.W. Norton, 1986), p. 60.

[14] Ray Marshall, "Jobs: The Shifting Structure of Global Employment," in *Growth, Exports, and Jobs in a Changing World Economy: Agenda 1988*, eds. John W. Sewell and Stuart Tucker (Washington, D.C.: Overseas Development Council, 1988, pp. 167-194).

Technology makes it possible to extend knowledge in a variety of ways, especially in its interactions with science (or the understanding of the principles that underlie how things behave). Scientific knowledge makes it possible to estimate how things will behave even *before* they are made. And technology makes it possible for scientific knowledge to be expanded. Learning curves and the ability to learn or think are critical to this process of producing new knowledge.

The Impact of Technology

The impact of technology is too pervasive and complex to be predictable, but a consensus is forming about several propositions:

1. Information technology will be ubiquitous, influencing high-tech as well as smokestack industries. While not many jobs will be created in the high-tech industries, the impact of the products of those industries will be pervasive. In other words, those smokestack industries that survive international competition will do so by using the products of high-tech industries. We should therefore distinguish high-tech *industries* from high-tech *products* and *occupations* used in all industries.

2. The synergistic and symbiotic relations between high tech and manufacturing industries have important implications for knowledge development. Manufacturing is required to give concrete form to technological innovations. Some industries (telecommunication, commercial aircraft) are technology drivers. If we lose the industry we lose the technological advantage. If we lose manufacturing we will likely lose the knowledge development associated with that equipment.

3. Technological change will combine with other forces to displace workers at an increasing rate. Some scholars debate whether technology will create more jobs than it destroys. Wassily Leontief, 1973 Nobel laureate in economics, points out that technology has always created unemployment. The difference is that technological unemployment has been voluntary in the past through greater leisure and less time spent on the job. However, without proper policies to achieve enough economic growth to absorb displaced workers, future technological changes could create massive involuntary unemployment. Leontief has developed a "fully integrated dynamic input-output matrix." Applying this model to the American economy, he concluded in 1986 that the intensive use of automation over the next 20 years will make it possible to conserve about 10 percent of the labor that would have been required to produce the same goods in the absence of increased automation. "Over

11 million fewer workers [could be] required in 1990 and over 20 million fewer in 2000."[15]

4. The impact of technology on the *quality* of jobs is also unknown. Some argue that technology will improve the quality of work by turning the most disagreeable jobs over to robots. Others point out that little skill is required to do most jobs in automated factories, so technological change will deskill and combine with other factors (international competition and demographic and political trends) to polarize incomes between the few haves and the many have nots. In addition, according to the pessimistic scenario, high-tech work also is likely to be more stressful.[16]

Determinants of the Impact of Technology on the Overall Level of Wages and Employment

The net employment effects of technological change will depend on the nature of labor markets. In competitive labor and product markets there would be no employment effects, though wages may be lower. If increasing productivity reduces the demand for labor, wages will fall if no offsetting increases occur in the demand for labor. If increased technology leads to lower prices, the employment effects depend on the price elasticity of demand. If elasticity is very large, a reduction in the price can lead to a sufficient increase in sales to keep employment constant or even to increase it. Technology that leads to the production of new goods can increase the demand for labor to produce those goods.

Although the theoretical conditions under which technological change could increase or reduce aggregate employment are easily specified, several factors make it difficult to determine the actual employment effects of technological change:

1. We have no analytical technique powerful enough to disentangle the complex interrelationships between changes in employment and technology. Moreover, no existing data bases on the distribution of employment, demography, industry structure, and occupations and skills are sufficiently related to each other to permit such an analysis, even if techniques were available.[17]

2. Most models assume the primary motive for technological change to be to reduce labor costs. However, other motives for technological change include improving capital flexibility and utilization rates; strengthening quality control; eliminating safety and health hazards; improving efficiency in the utilization of energy and materials; simplifying design procedures; centralizing, decentralizing, or controlling production processes; and gaining greater control over the work force, especially to reduce the power of unionized workers.

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[15] Wassily Leontief and Faye Duchin, *The Future Impact of Automation on Workers* (New York: Oxford University Press, 1986), p. 12.

[16] Karen Nussbaum, "High Tech, Low Blow?" *New Realities*, Summer 1986, p. 10.

[17] T.L. and H.A. Hunt, "An Assessment of Data Sources to Study the Employment Effects of Technological Change," W.E. Upjohn Institute for Employment Research, October 1984, Appendix on Data Sources.

3. Similarly, technology can affect the demand for labor without changing productivity by increasing the durability and reliability of products; by broadening the market for products by improving performance characteristics; and by facilitating the shift of production from controlled to flexible markets.

Studies of long-term trends have not found dramatic net increases in unemployment because of technological change. A study of Organization for Economic Cooperation and Development (OECD) countries found that employment had tripled since 1880 despite the fact that mechanization had eliminated two-thirds of the jobs that had existed just before 1880.[18]

A very important point from the standpoint of competitiveness as defined in this paper is the fact that employment seems to have increased fastest in those countries that were the first to adopt labor-saving technology. The correlation is not perfect, however. Although U.S. companies adopted microelectronic technologies faster than their European competitors and the U.S. has had faster job growth, Japan introduced this technology even faster than the U.S. and has had slower job growth than the U.S.[19] However, during the 1970s only the U.S. had faster employment growth than Japan. Real wages and productivity increased faster in Japan than in any OECD country, while real wages fell in the United States and productivity growth was stagnant. Moreover, among the LDCs, the newly industrializing "little Japans" in Southeast Asia have adopted modern technology most rapidly and have had the greatest growth in employment.

The same pattern seems to hold within manufacturing--those sectors with the greatest total factor productivity (TFP) growth also have had the greatest employment growth.[20] Between 1948 and 1976 communications, semiconductor, electrical and electronic equipment industry groups all had high rates of growth in TFP, less than average price increases, and greater increases in employment than the rest of the economy. On the other hand, manufacturing as a whole has had slower employment growth than the services, which usually had lower wages than in manufacturing.[21]

A 1982 case study by Ayres and Miller predicted that the introduction of robots in metalworking would not have large aggregate effects on national employment but would create severe unemployment in the five Great Lakes states.[22] However, predictions about the impact of the future rate of robotics vary widely and seem to be highly judgmental and biased by the short-term optimism of robotics experts and manufacturers who have a vested interest in the rapid introduction of robotics. The actual use of robots by General Motors, the American auto company relying most heavily on this technology, has been very disappointing. Although GM's difficulties could be due to start-up problems, as noted above, so far its highly automated Lansing, Michigan facility has been less productive than its joint venture with Toyota (NUMMI) in Fremont, California.

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[18] Max Geldens, "Towards Fuller Employment," *The Economist*, July 28, 1984, pp. 19-22.

[19] U.S. Department of Commerce, *Information Computer Communication Policy No. 7*, 1982, table 1, p. 27.

[20] U.S. Department of Commerce, *Information Computer Communication Policy No. 5*, 1982, pp. 29-31.

[21] Barry Bluestone, Bennett Harrison and Lucy Gorham, "Storm Clouds on the Horizon: Labor Market Crisis and Industrial Policy," Boston, Economic Education Project, May 1984.

[22] R.W. Ayres and S.M. Miller, "Robotics and the Conservation of Human Resources," *Technology in Society*, vol. 4, no. 3, 1982, pp. 181-197.

A 1984 report by the Office of Technology Assessment (OTA), *Computerized Manufacturing Automation*, which limited its analysis primarily to existing and immediately forthcoming applications of well-established technologies, concluded that programmable automation (PA)[23] was unlikely to have measurable employment effects for the rest of this century. However, like the study by Ayres and Miller cited earlier, the OTA report predicted negative employment effects from programmable automation in regions where metalworking is concentrated. The OTA report also concluded that the impact of technology may be less important than such factors as changes in business cycles; world market shifts; taste; exchange rates; international competitiveness; macroeconomic policies; wage, productivity, and education levels; labor mobility; and occupational adaptability.[24]

Many studies have attempted to assess the impact of technology on the international division of labor. According to one perspective, the production of standardized manufacturing products gradually will be shifted to the developing countries, leaving the production of more technologically advanced, customized, high-fashion, design-intensive, and high value added production in the industrialized countries.[25] Those who hold this view believe that the standardization of product designs and productive technologies makes these processes readily transferable to low-wage Third World countries. Although some evidence supports this argument, critics question its main premise, pointing to the repatriation of production to the developed countries as production technology becomes more sophisticated and capital intensive.[26] According to this view, other factors will outweigh labor costs and therefore cause production to concentrate in the developed countries, especially the need for better-trained and better-educated workers, the costs of materials, and the proximity of customers and suppliers. Changes in production technology give an advantage to companies with the close integration of design, production, and marketing. Moreover, the economic stagnation and debt problems of many Third World nations make it less attractive for international corporations to locate manufacturing facilities in those countries. Developments in materials production and chemicals likewise apparently have reduced the demand for primary products, which, other than low wages, was the chief advantage of locating in Third World countries.

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[23] PA tools differ from conventional automation primarily in their use of computer and communications technology. They are therefore able to perform information processing as well as physical work, to be reprogrammed for a variety of tasks, and to communicate directly with other computerized devices. PA can be divided into three categories: computer-aided design (CAD); computer-aided manufacturing (CAM); and computer-aided techniques for management (CATM). When these tools are used in a system with extensive computer-based coordination, the system is known as computer-integrated management (CIM). Numerically-controlled (NC) machine tools cut or form pieces of metal according to programmed instructions. Flexible manufacturing systems (FMS's) combine a set of workstations with robots or other devices to move material between stations and operate under central computer control. Experts also make a distinction between "hard" automation systems based on machine tooling complexes and assembly lines designed to do one thing and "soft" automation that is capable of performing multiple tasks. Soft automation is based on CAD/CAM and involves automated warehouses and parts transport combined with programmable machine tools and grouped with multifunctional robots and robotic assembly, inspection, packaging, and shipping systems. The result is a very flexible manufacturing system.

[24] Office of Technology Assessment, *Computerized Manufacturing Automation: Employment, Education, and the Workplace*, OTA-CIT-236, April 1984.

[25] See C.F. Sabel, *Work and Politics: The Division of Labor in Industry* (New York: Cambridge University Press, 1982).

Skilling or Deskilling

Assessing the impact of technology on job skills is equally difficult. A major reason for this difficulty is the fact that technological change combines with other forces, especially the degree of competition and management philosophies, to determine whether or not the economy of the future will require workers to have fewer, more, or different skills. This issue clearly has important implications for the kind of learning systems we will need in the future.

Some labor economists have argued that industrialization requires higher skills and higher levels of education because workers must be more mobile, deal with more complicated equipment, and understand more complex processes.[27] Others argue that industrialization and/or capitalism lead to deskilling because the technology permits management to fragment and deskill jobs in order to control labor. Indeed, fragmentation and deskilling were the major objectives of scientific management, which has been so influential with American managers.[28] Moreover, some analysts develop a polarization variant of the deskilling argument--i.e., that technology and other economic forces tend to create many low-paying and a few high-paying occupations.[29] Another version of the downgrading thesis is the argument that technology and market forces tend to *proletarianize* jobs, i.e., to eliminate nonworking-class and create working-class positions.[30] For some analysts, deskilling is a consequence of the tendency for deindustrialization to eliminate high-paying jobs and create low-paying ones.[31]

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[26] *Fortune*, June 11, 1984, p. 152; *Electronic Business*, February 1984, p. 178.

[27] Clark Kerr, John Dunlop, Frederick Harbison, and Charles Myers, *Industrialism and Industrial Man* (New York: Oxford University Press, 1964).

[28] H. Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974); P. Kraft, *Programmers and Managers: The Routinization of Computer Programming in the United States* (New York: Springer-Verlag, 1977); Joan W. Scott, "The Mechanization of Women's Work," *Scientific American*, vol. 247, no. 3, September 1982, pp. 166-187.

[29] Eli Ginzberg, "The Mechanization of Work," *Scientific American*, vol. 247, no. 3, September 1982, pp. 67-75; R. W. Rumberger, *A Conceptual Framework for Analyzing Work Skills*, Project Report No. 83-A8 (Stanford, California: Institute for Research on Educational Finance and Governance, 1983).

Spenner notes that skill changes can occur because of changes in the content of jobs or because of the composition of jobs (i.e., more less-skilled jobs than skilled). He also notes that deskilling can refer to the skills possessed by workers or to those required by the jobs they occupy and can measure jobs directly or indirectly (i.e., by taking schooling, wage levels, or some other measure as an indicator of skills).

Spenner concludes from a summary of a number of macro studies that:

> the general impression is one of approximate aggregate stability. There is no evidence that jobs taken as a group are experiencing dramatic upgrading or downgrading in terms of skill requirements. This does not mean an absence of upgrading and downgrading, but rather an approximate balance in the direction of and quantity of changes or an approximate conservation of total skill.[32]

The main conclusion Spenner reaches from a detailed review of a number of case studies is "that firm conclusions--ones generalizable and replicable across studies--are not available."[33]

Effects of Technology on the Need for Education

Spenner contends that most policy recommendations about requiring subjects such as science, mathematics, community education, technology, or general skills to make people more adaptable "assume more knowledge about the nature of occupational skill transformation" than exists. His summary suggests that a "substantial literature [shows that] generalized vocational education assists people in landing jobs and launching careers, but only modestly predicts success in the work place."[34] He believes the evidence supports the need for greater attention to literacy and high school level basic competencies, "rather than dramatic new forms of education and training." Other analysts also recommend more general education and less narrow vocational training.[35]

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[30] E. Wright and J. Singlemann, "Proletarianization in the Changing American Class Structure," in *Marxist Inquiries*, eds. M. Burawoy and T. Skocpol (Chicago: University of Chicago Press, 1982), pp. 176-209.

[31] Barry Bluestone and Bennett Harrison, *The Deindustrialization of America* (New York: Basic Books, 1982); L.A. Ferman, "The Unmanned Factory and the Community," *Annals of the American Academy of Political and Social Science*, vol. 470, 1983, pp. 136-145.

[32] Kenneth I. Spenner, "The Upgrading and Downgrading of Occupations: Issues, Evidence, and Implications for Education," *Review of Educational Research*, Summer 1985, pp. 140-141.

[33] Ibid., p. 42.

[34] Ibid., p. 147.

Spenner is skeptical of arguments that education and training play a role in reducing unemployment and improving productivity and help people adapt to technological change and achieve job satisfaction, personal growth, and equality of opportunity; he contends that "several types of studies suggest caution and limited expectation versus optimism and unlimited expectations."[36] Berg, et al.,[37] for example, conclude that there is "no solid evidence [that] better educated [or] better trained [persons] perform better than the less well-educated and less well trained (pre-job training) persons in the same occupation." In other words, ". . .time and resources spent studying and improving the process that matches workers to jobs may yield far greater return than across-the-board increases in schooling and training."[38]

Other education researchers concur with this conclusion. For example, two well-known education analysts at Stanford's Institute for Research on Educational Finance and Governance, Henry M. Levin and Russell W. Rumberger, argue that, with the exception of a relatively small number of highly specialized positions, most new jobs will not require higher levels of skill.[39] These analysts cited Bureau of Labor Statistics (BLS) data showing that only four of the top twenty occupations in absolute number of new jobs between 1978 and 1990 require education beyond high school and only two--teaching and nursing--require college. They expect the growth of professional and managerial jobs to slow down during the 1980s relative to the 1960s and 1970s. They also expect high tech to deskill many jobs, to "further simplify and routinize work tasks, reducing opportunities for individuality and judgment." Moreover, "the displacement of skill requirements for most of the new positions will undermine employment generally and especially the employment of skilled workers." These analysts expect advances in software to enable many workers to use computers without any knowledge of computer languages.

> Machines will be able to perform more complex, mental tasks as more advanced software is developed [illegible]t the use of such sophisticated equipment will not necessarily require workers with more sophisticated skills. In fact, past technological advances suggest the opposite is often the case. . .Entire classes of skilled workers will disappear or will be severely reduced in numbers as their jobs are replaced by robots or computer software.

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[35] Henry Levin and Russell Rumberger, "The Low-Skill Future of High-Tech," *Technology Review*, vol. 86, no. 6, 1983, pp. 18-21.

[36] Spenner, "Upgrading and Downgrading," p. 149.

[37] I. Berg, R. Bibb, T.A. Finegan, and M. Sawfford, "Toward Model Specification in the Structural Unemployment Thesis: Issues and Prospects," in *Sociological Perspectives on Labor Markets*, ed. I. Berg (New York: Academic Press, 1981), pp. 347-367.

[38] Spenner, "Upgrading and Downgrading," p. 150.

[39] "Required Job Skills Will Drop, Despite High Technology," *Stanford Observer*, May 1983.

In 1976 Richard Freeman joined the skeptics and critics. He argued that the large baby boom cohort entering the work force during the 1970s was actually overeducated. Freeman compared young college graduates with high school graduates of the same age and found that the earnings of college graduates declined relative to high school graduates during the 1970s.[40]

Smith and Welch criticized Freeman's work. They contend that the relative decline in earnings was observed only for new entrants into the work force and was exaggerated by Freeman's failure to control for experience as well as age; when this adjustment is made, the decline in the rate of return was only about half as large as suggested by Freeman (i.e., 1 rather than 2 percent). Moreover, the decline in the rate of return bottomed out and reversed itself during the late 1970s. Smith and Welch also found that the wages of new entrants relative to peak earners declined for all occupational groups, not just for college graduates, although the effects were somewhat larger for college graduates. Smith and Welch conclude, therefore, that rather than overeducation, young workers at all education levels experienced lower returns to education during the 1970s because of an increased supply of young workers and declining aggregate demand. They also believe these lower returns are likely to be temporary and should increase during the 1980s and 1990s when fewer young people will enter the work force.[41] The evidence suports this position; as we shall see below, there has been a marked widening of the gap between the income of college-educated workers relative to those with less education.

Of course, the concept of over- or under-education has little meaning in a dynamic economy where demand and supply conditions are in a constant state of adjustment. To be meaningful, moreover, concepts like *shortages* and *surpluses* of labor must specify wage rates. Analysts ordinarily mean there is a surplus (or shortage) when more (or less) workers are able to find work at existing wages and conditions. Of course, in a perfectly competitive market there would be neither "shortages" or "surpluses" of workers.

A June 1987 study by the Hudson Institute also disagrees with the deskilling hypothesis. This study forecasts a trend toward higher education requirements among the fastest growing jobs over the 1984-2000 period.[42] Assuming the same skill requirements for occupations in 2000 as in 1984, the average gain in education requirements will be 25 percent across all occupational categories, but a growth rate of two to three times faster is expected for the fastest-growing fields--lawyers, scientists and health professionals (table 1). In the mid-1980s only 22 percent of jobs required college degrees, but more than half of all the jobs created between 1984 and 2000 (assuming education requirements for new occupations to be the same as for those occupations today) are projected to require education beyond high school "and almost a third will be filled by college graduates."[43]

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[40] Richard B. Freeman, *The Over-Educated American* (New York: Academic Press, 1976).

[41] James Smith and Finis Welch, "The Over-Educated American?" *Proceedings of the National Academy of Education*, vol. 5, 1978.

[42] William B. Johnston, *Workforce 2000: Work and Workers in the 21st Century* (Indianapolis, IN: Hudson Institute, 1987).

Table 1

Median Education Requirements for Current and Future Jobs

	Current Jobs	New Jobs, 1980-84
Total	100%	100%
8 years or less	6	4
1-3 years of high school	12	10
4 years of high school	40	35
1-3 years of college	20	22
4 years or more college	22	30
Median years of school	12.8	13.5

Source: William B. Johnston, *Workforce 2000: Work and Workers in the 21st Century* (Indianapolis, Ind.: Hudson Institute, 1987), p. 98.

As these data show, the work force's median years of schooling was 12.8 in the mid-1980s, but the median for the new jobs will be 13.5. Compared with the current work force, smaller percentages of new jobs are expected to require high school or less and more will require some college. The proportion of jobs expected to require four or more years of college is 30 percent contrasted with 22 percent of current jobs. Of all the job categories growing faster than average (i.e., 25 percent), only one, services, which is expected to increase by 37 percent, will require less than the median level of education for all jobs. If all jobs are ranked according to the skills required (i.e., language, math reasoning, reading) on a scale of 1-6, where 6 is the highest, the fastest-growing jobs have much higher math, language, and reasoning capability requirements than the mid-1980s jobs. Declining occupations, by contrast, have some of the lowest skill requirements.

The Hudson Institute study found that while projected 1984-2000 employment growth is weighted toward highly skilled occupations, a very large number of jobs also will have medium-to-low skill requirements. Among the largest job-growth categories in absolute terms (services, administrative support, marketing and sales account for half of the net new jobs), only one subset of the services category, computer operators, requires more than average skill levels.

> But even for these jobs, whose typical skill scores fall in the middle of the current range. . .workers will be expected to read and understand directions, add and subtract, and be able to speak and think clearly. In other words, jobs that currently are in the middle of

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[43] Ibid., p. 97.

> the skill distribution will be the least skilled occupations of the future, and there will be very few net new jobs for the unskilled.[44]

In addition, even though they may have higher skill requirements in the future, "these middle/low-skilled jobs are concentrated in service industries in which wage gains and productivity growth traditionally have been weak." [45]

Assessing the impact of technology on jobs skills thus involves assessing obstacles to change and sorting out conflicting tendencies and assumptions. As noted, one line of thought holds that technology will deskill some jobs but on balance will create jobs that are more highly skilled than those displaced. This position draws on sociological theories about modernization and the division of labor, as well as evidence with respect to the growth in the proportion of "professional and technical workers in the work force."[46] According to those who argue for deskilling, new technology tends to redistribute skills from production workers to machines, technical personnel, and managers.[47]

The deskilling hypothesis is, in addition, supported by the scientific management tradition in U.S. companies. Despite evidence of their inappropriateness for modern production systems, the methods and beliefs developed and popularized by Frederick W. Taylor almost a century ago have left a very strong imprint on American companies and schools. The Taylor, or technocentric model, involves the following main elements:

1. fragmented tasks and a minute division of labor among workers;
2. many layers of management and technical staffs;
3. the belief that there is "one best way" to organize and perform work and that it is management's responsibility to develop those "best ways" and impose them on workers;
4. the development of rigid work rules to protect the interests of both managers and workers; and
5. the belief that efficiency requires an authoritarian management system in which management has unchallenged control of the design and introduction of technology; investment, plant closing, and location decisions; and job functions and qualifications. In short, workers are to become integral parts of the production

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[44] Ibid, pp. 99-100.

[45] Ibid., p. 100.

[46] National Science Foundation, "Changing Employment Patterns of Scientists, Engineers and Technicians in Manufacturing Industries: 1977-80," NSF Report 92-331, October 1982.

[47] J. R. Bright, "Does Automation Raise Skill Requirements? *Harvard Business Review*, July-August 1958, pp. 84-98; H. Braverman, *Labor and Monopoly Capital.*

process, thoroughly integrated with the machines.[48] Efforts by American managers to maximize managerial control and minimize labor input have been an important driving force in the development and implementation of computerized manufacturing.[49]

Despite the unquestioned strength of Taylorism among American managers, there have been some strong impediments to its realization. Historically, one of the most important of these has been the technical inability to fragment the work of highly skilled workers. However, some observers, including *Iron Age*, believe numerically controlled tools finally have made it possible to realize Taylor's dream.[50] Nevertheless, there is mounting evidence of continuing resistances and counterforces to Taylorism. One of the most important of these has been the continued and growing importance of traditional skills in automated processes, despite the contrary hopes of authoritarian managers and machine vendors. As Brooks, Schneider and Oshima emphasize:[51]

> In practice, companies have found it impossible to fully separate the programming of the NC machine from its operation because it is often necessary to modify the program as it is being used. The result is that more than originally anticipated, experienced machinists are needed to operate the equipment effectively and to avoid expensive breakdowns or quality control problems.

One reason for the continued need for skilled workers is the difficulty that management has had in debugging production systems. If management attempts to separate programming from the work place and put it in programming or engineering departments with little actual hands-on work experience, serious damage and down time to very costly capital can result.[52]

A second problem is quality control, which can only be checked at the end of an automated systems process. "By the time a defect is discovered, the work piece has already entered into another stage in the process, or a machine tool has been damaged. It is also more difficult to identify the causes of defects, a critical issue because of the need for prompt corrective action."[53] Experiences in process industries like chemical and nuclear plants suggest that the absence of skilled workers at critical points in the production process often causes minor problems to become very costly disasters.[54] Brooks et al., conclude:

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[48] E.T. Layton, Jr., *The Revolt of the Engineers, Social Responsibility and the American Engineering Profession* (Cleveland, Ohio: Case Western Reserve University Press, 1971), Ch. 6.

[49] D.F. Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Alfred A. Knopf, 1984).

[50] Harley Shaiken, *Work Transformed* (New York: Holt, Rinehart & Winston, 1984).

[51] H. Brooks, L. Schneider, and K. Oshima, "Potential Impact of New Manufacturing Technology on Employment and Work," November 2, 1985, p. 24. (Draft.)

[52] M.R. Kelley, "The Problems in Implementing Programmable Machinery: Lessons from U.S. Experience," Intergovernmental Bureau of Informatics, The United Nations, March 1985, cited by Brooks, et al., "Potential Impact," p. 26.

> Numerous case studies suggest that skilled machinists perform better on computerized systems than those without such experience. Informal interventions, improvisation, and negotiated unsanctioned transactions between workers are much more important to the smooth operation of even the most automated production processes than is often recognized by managers and planners. All of this suggests that the traditional Taylorist management approach may often be creating obstacles to the effective uses of new manufacturing technology in practice.[55]

With respect to whether technology deskills and creates the need for higher level and different skills, Brooks et al. conclude that:

> There are evidences of both trends occurring simultaneously. Probably the most clear effect is that the availability of high paying, high value-added jobs for relatively low-skilled people is drying up. Furthermore. . .there appears to have been a trend towards bifurcation of the work force into high-skilled and low-skilled tasks (with corresponding pay levels) and much less growth of occupations in between. There is disagreement as to whether this is a temporary phenomenon due to the low capitalization of services relative to manufacturing or whether it is a new and more or less permanent trend.[56]

CONCLUSIONS

The main conclusion of this chapter is that nobody knows what the net effect of the new technology will be. The impact is too pervasive and will be conditioned by a very complex constellation of forces. Moreover, while the new technology has acquired a life of its own, it is not independent of social systems and decision processes, so people can have a lot to say about what its effects will be; they can either tilt it toward the optimistic or the pessimistic scenarios. As noted earlier, the past impact of technology is very difficult to determine, but the key to the nature of its future use will be whether or not we want to be a high-income country.

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[53] M. Blumberg and D. Gerwin, "Coping with Advanced Manufacturing Technology," *Journal of Occupational Behavior* vol. 5, no. 2, April 1984, p. 123.

[54] J. Fadem, "Automation and Work Design in the United States," in *Automation and Work Designs*, eds. F. Butera and J.E. Thurmes (Geneva: North Holland Publishing Company, 1984), pp. 647-721.

[55] Brooks et al., "Potential Impact."

[56] Ibid., p. 56.

Despite these uncertainties, several hypotheses are worth exploring.

1. Emerging technologies will produce rapid changes, placing a premium on adaptable organizations, institutions, individuals and policies. The inflexible will continue to have great trouble. Too much displacement probably will not occur in the short run (i.e., 10-15 years) but there will be more in the 1990s and beyond when many of the more sophisticated systems become more widely utilized.

2. The employment effects of high tech will depend heavily on improved national policies and more effective private management systems. The critical assumptions behind the optimistic scenario are (1) that national and world economic growth will absorb workers who are displaced by technology; (2) that markets or other processes will make it possible for resources to be shifted into alternative employment as workers are displaced by technology; and (3) that cooperative, participatory management systems are developed.

3. The use of the most productive technology must play an important role in the competitiveness of American industry. Clearly it will be difficult for American industry to compete with many of the newly industrializing and Third World countries in industries where wages determine competitiveness. American companies must therefore compete through better management systems (where our experience is mixed, but where we have no clear advantage over the most competitive countries following the Swedish or Japanese models), technical competence (where we still have a substantial, though diminishing, lead), and the quality of our human resources (where we have significant room for improvement). American public and private management systems must therefore give much greater attention to education, research, and training. As noted, experts debate whether the industry of the future will require more or less education. While it will be possible to perform many tasks in the high-tech workplace with limited education, the most effective operations of that workplace will require more, better, and different kinds of education. Workers will have to have much more knowledge than they use at any given time in order to repair equipment, solve problems, communicate with and coordinate parts of worldwide production processes, and participate more effectively in management. Moreover, one of the most important skills in the competitive work force of the future will require more attention to learning, the analysis of data, the management of responsibility, and the ability to use abstractions. The most competitive workplaces of the future probably will blur the lines between management and workers and more worker ownership and control will take place.[57] Management in the most competitive enterprises will be more concerned about worker security because that strengthens management, as well as worker, commitment to quality and productivity, human resource development within the firm (where more and more education and training will take place), and flexibility in human resource use. There is a direct relationship between employment security and management's willingness to finance the human capital investments required in the most competitive work places. Occupational and craft definitions based on the goods-producing world of the 1950s and earlier will be obsolete in the automated, internationalized information world of the future. Workers in the most competitive firms will no longer rely exclusively on wages but will rely increasingly on such

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[57] For a development of this theme see Ray Marshall, *Unheard Voices: Labor and Economic Policy in a Competitive World* (New York: Basic Books, 1987).

nonwage compensation as productivity-based bonuses and ownership dividends. These income systems also will compensate workers more for what they know than for what they do. While management will be more concerned about worker security, workers and their organizations will concern themselves more with the economic viability of the enterprises where they work. The most competitive enterprises also are likely to lose their national identities except for their locations and the nationalities of their workers and are more likely to maximize long-run market shares and employment than short-run profits. However, in the absence of effective national policies, the use of subcontractors and part-time workers to gain greater external flexibility could polarize the work force between those with and those without adequate incomes and job security.

Strong evidence indicates that worker participation can improve the introduction of technology. In this respect robots and automated systems have been much more readily accepted by Japanese than American workers. Just about every company has had some problem with acceptance of the robot. American workers not only fear that robots will displace them, but they also are concerned about deskilling and loss of job control. Glenn Watts, former president of the Communication Workers of America, sees a growing trend toward centralization of management control and the deskilling of shop-floor jobs into mindless tasks where workers have no sense of service or accomplishment."[58]

Japanese workers and their unions, by contrast, generally welcome the introduction of technology. The Japanese government maintains economic policies to promote low levels of unemployment (generally less than 3 percent) and inflation and optimal growth in productivity, national income, real wages and living standards. These measures include a relatively successful strategy to develop human resources and technology and to facilitate the orderly, efficient, and equitable shifting of resources out of noncompetitive into more competitive sectors, as well as measures to improve the competitiveness of the former.

Japanese workers and their unions (which represent about 30 percent of Japanese workers and a majority in the larger companies) also welcome the introduction of technology because Japanese compensation systems cause workers to benefit directly from the increased productivity resulting from new technology. Regular Japanese workers in major companies not only have lifetime employment but also receive perhaps one-third of their annual compensation from a bonus paid twice a year based on overall company performance. This compensation system tends to increase flexibility and personal savings and minimize the workers' resistance to change. Japanese workers not only benefit directly and clearly from the introduction of technology, but they and their unions also are involved in the planning decisions leading to the installation of robots and other systems. American workers, by contrast, do not ordinarily participate in such decisions, which usually are made unilaterally and in secret by management.

In view of these differences it is not surprising that many American firms are making much less effective use of information technology than their Japanese competitors. American workers see little relationship between productivity improvements and their personal welfare. A 1983 *Public Agenda* study of American and

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[58] Personal conversations with the writer.

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Japanese workers found that 93 percent of the Japanese but only 9 percent of the Americans thought they would benefit from higher productivity. Less than 25 percent of the Americans said they were working at full capacity and almost three-fourths (73 percent) saw no connection between their compensation and how hard they worked.

Demographic and Labor Market Changes

Demographic changes are more predictable than other trends. This is because long-run trends tend to be set by the age composition of a population and relatively slowly changing birth and death rates. Thus, about three-fourths of the people who will be working in the year 2000 are currently employed and all of those who will be working for the rest of the century already have been born. The wild card on population projections is immigration. Some of the most important demographic trends include the aging of the work force and the declining proportion of whites and the increasing proportion of minorities.

Many more old people and many fewer young ones will make up the work force. Because of the baby bust that started in the late 1950s and lasted for 20 years, in 1995 there will be 20 percent fewer teenage workers than in 1975. Between 1975 and 1985 young people aged 16-18 declined by 14 percent, and there were 5 percent fewer 18-24 year olds in 1985 than in 1980. By 1990 there will be 4.3 million fewer people 18-21 years old than in 1980. The labor market share of 16-24 year olds will decline from 30 percent of the work force in 1985 to 18.4 percent in 1990 and 16 percent by 2000. The average age of the work force will increase from 35 in 1985 to 39 in 2000.

An estimated 29 percent of the net increase in the work force between 1985 and 2000 will be minorities. In 2015 the U.S. population will contain 91 million minorities, 3 million more Hispanics than blacks. Minorities will be 34 percent of the population (contrasted with 17 percent in 1984) and probably a higher proportion of the work force. Almost all of the net increase in the work force will be women and minorities. These changes are mainly because of immigration and the age distribution of each group. According to the 1980 census the average white person was 31 years old, the average black 25 and the average Hispanic 22.[59]

These demographic changes will be accompanied by important labor market developments. The increased labor market participation of women will continue to challenge prevailing employment practices. Women will become much more important actors in political and economic affairs. Considerable tension will develop between women and those males and male-dominated institutions that resist change. Despite the negative attitudes toward "comparable worth" in some political and business circles, the elimination of sex-based pay discrimination will become a more important personnel practice in most large public and private organizations. Women will, in addition, continue to expand their proportion of nontraditional, male-dominated jobs. In large part these changes will come because, for the first time, young women entering the work force are better educated than young men. Moreover, women are developing the organizational and political mechanisms to challenge sex-based discrimination.

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[59] For a detailed study of the Texas population trends and their political, economic, and labor market implications, see Ray Marshall and Leon Bouvier, *Population Change and the Future of Texas* (Washington, D.C.: Population Reference Bureau, 1986).

The increased labor force participation of women will accompany continued change in family structures.

1. In 1950, 70 percent of American families were headed by men whose wages were the sole source of income. Today less than 10 percent fit that description.

2. Half of all marriages in the 1980s will end in divorce. U.S. divorce rates are the highest in the industrialized world.

3. Sixty percent of the children born in the 1980s will spend at least part of their lives with only one parent. Ninety percent of these families are headed by women, and these families are much more likely than two-parent families to be poor.

4. An upward trend in children born to unmarried mothers will continue. The rates are particularly high for blacks but are increasing for all. Pregnancies for American white teenagers are the highest for any major industrialized country.

5. Women will continue to marry at later ages and have fewer children.

6. Most unmarried teenage mothers will not complete high school.

7. Black male teenagers will continue to experience declining work experience. From the mid-1960s to the mid-1970s black male teenage labor force participation declined from about 67 percent to 47 percent, while the white teenage participation rate remained about the same. Black male joblessness is related to the number and proportion of unmarried black mothers.

8. The problems of minorities and whites with limited education will cause youth unemployment to continue to be a serious problem, despite the declining numbers of young workers. The fact that minorities will constitute a large proportion of the work force growth means that their poor levels of education and training will be a serious and growing national and Texas problem. In fact, the future of both the nation and Texas depends heavily on how we deal with education and training equity problems.[60]

   Minorities have lower overall scores on standardized tests for educational achievement. In some urban areas the dropout rate, which runs 30 percent nationally, is 40 to 50 percent for minorities. Family structure developments have clear implications for public schools. The most effective learning experiences require supportive family and home environments and parental participation in the schools and home learning experiences. Schools often have been called upon to compensate for inadequate home environments in which there is only one parent, incomes are low, parents have limited education, or parents have to spend so much time making a living that they have limited time for school or to help their children learn. Teachers and school administrators must understand the background factors of their students if they are to provide effective learning experiences. Education problems will be particularly serious for poor mothers with limited education, and their problems will be transferred to their children. As we shall see later in this report, family income is the main predictor of educational achievement. Moreover, the development of children depends heavily on their health at birth and the early nurturing and learning they experience with their caregivers. Poor, uneducated mothers are less likely either to have healthy babies or to give their children adequate nurturing before they enter school. Many poor children therefore start school behind more affluent children in education achievement. These matters, explored at greater length below, likewise make it clear that education improvements will require high priority to pre-school and early childhood development programs to break the intergenerational nature of poverty and poor education achievements.

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[60] For a detailed population and labor force projections for Texas, see Marshall and Bouvier, *Population Change*.

Some observers expect the lower proportion of young people to create labor shortages. Whether or not this happens depends on the flexibility of the work force, the rate of economic growth, and the rate of immigration. Immigration is expected to continue at high rates for the rest of this century (i.e., at least 500,000 a year and 20-30 percent of the growth of the labor force) because of the economic conditions in Mexico and other developing countries and because of the difficulty of developing effective immigration policies. Immigrants will compete with and depress the wages of undereducated young people. There are, however, likely to be shortages of technically trained, educated young workers. Those who are well educated, trained, and highly motivated will have very good economic opportunities.

There are not likely to be overall labor shortages for the rest of this century. In fact, in the absence of more effective economic and labor market policies, rising joblessness will be caused by immigration, the increasing proportion of minorities, technological change, and slow growth. However, with the proper economic and labor market policies, tremendous capacity for rapid economic growth is provided by unemployment, excess capacity of plant and equipment, and technological change.

However, shortages of some workers will continue, due primarily to aging and demographics. For example, the average age of the country's 300,000 skilled machinists was 58 in 1985 and training systems produce only about a fourth of the skilled machinists needed each year. Similarly, about half of the nation's primary and secondary school teachers will retire between 1985 and 1991. These were the teachers of the baby boom generation whose children are now in the schools. Since there have been increased job opportunities for women and minorities in other occupations, fewer are entering teaching. Thus, the increased demand and reduced supply will create a very serious shortage of qualified teachers.[61]

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[61] Of course, the concept of labor shortages is relevant only at specified salaries and qualifications. Some observers argue that there will be no teacher shortage because in the first half of the 1980s rising teachers' salaries and education reform were attracting more people into teaching. Those who contend that there will be no shortage also argue that the salaries of teachers are not out of line with comparable college graduates. However, these arguments assume that marginal changes in our present education system are adequate. Those of us who believe there need to be radical improvements in the education system in order to make it world class believe it is not enough just to get warm bodies to stand before classes and "teach." Indeed, we do not believe baccalaureate degrees in education are adequate preparation for teaching. In this latter sense, a serious teacher shortage will occur in the absence of radical changes in teachers' compensation, status, working conditions and power. For

The aging of the population could create problems for the country's retirement systems. In 1935, when the social security system was formed, there were ten workers for each retired person. In 1980 there were three to one and, if present trends continue, by 2020 there will be two to one. There will thus be greater pressure for older workers to remain in the work force and there could be increasing tensions between older and younger workers.

Rapid change will continue to displace workers, leading to greater needs for policies to facilitate the adjustment of workers from less to more competitive economic activities. In the absence of effective policy changes significant mismatches in the labor market that will cause serious disruptions in the economy and make it difficult to achieve orderly growth are likely to continue. All of these changes could contribute to a continuing polarization of income, though, as will be discussed later, many of the reasons for polarization are not directly related to the work force, including teenage pregnancies, rising unemployment, poverty, limited education and training of young blacks and Hispanics, and female-headed households.

Employment and Wages

The job growth trend in the U.S. for the rest of the century probably will continue to be what it has been--90 percent of all the new jobs will be in the services and goods-producing jobs will decline. In 1985, about 70 percent of America's workers were in the service sector and service-related activities and only about 20 percent were in manufacturing (figures 3a-3c and 4). Manufacturing employment fell from 34 percent of all jobs in 1950 to 25.1 percent in 1959 and 18.5 percent in 1984. The total number of manufacturing jobs declined from a peak of 21.04 million in 1979 to 19.11 million in 1987. Moreover, in 1987 despite five years of recovery, the manufacturing sector of the economy had recovered only 26 percent of its 1981-82 recession losses. Indeed, this country has created no net additional manufacturing jobs since the late 1960s. In terms of output, manufacturing declined from 38.2 percent of gross output in 1969 to 35.2 percent in 1981 and 34.5 percent in 1984. Thus, manufacturing's share of total output has declined less than its share of total employment. In terms of total real dollars, manufacturing increased slightly from $1.45 trillion in 1979 to $1.49 trillion in 1984.[62]

Paralleling the decline of manufacturing work has been the rise of service employment. It is important to remember, however, that service jobs vary greatly. Some, particularly those in producers' and business services, pay well and require high skills. Producers' services--legal, accounting, computing, business, and engineering--have experienced rapid growth, albeit from a relatively small base. Other sectors--retail services, consumer and personal services, and wholesaling--have generated mostly low-paying jobs. These jobs have increased most in absolute number while the

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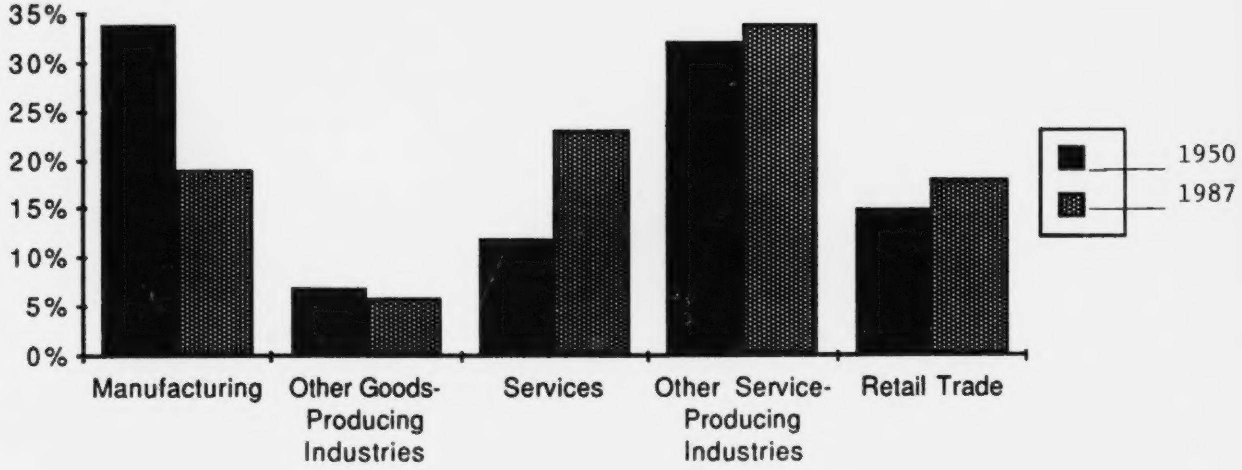
an elaboration of this point, see Carnegie Forum on Education and the Economy, Task Force on Teaching, *A Nation Prepared* (Washington, D.C.: Carnegie Corporation, 1986).

[62] Ronald E. Kutscher and Valerie A. Personick, "Deindustrialization and the Shift to Services," *Monthly Labor Review*, June 1986, pp. 3-13.

Figure 3a

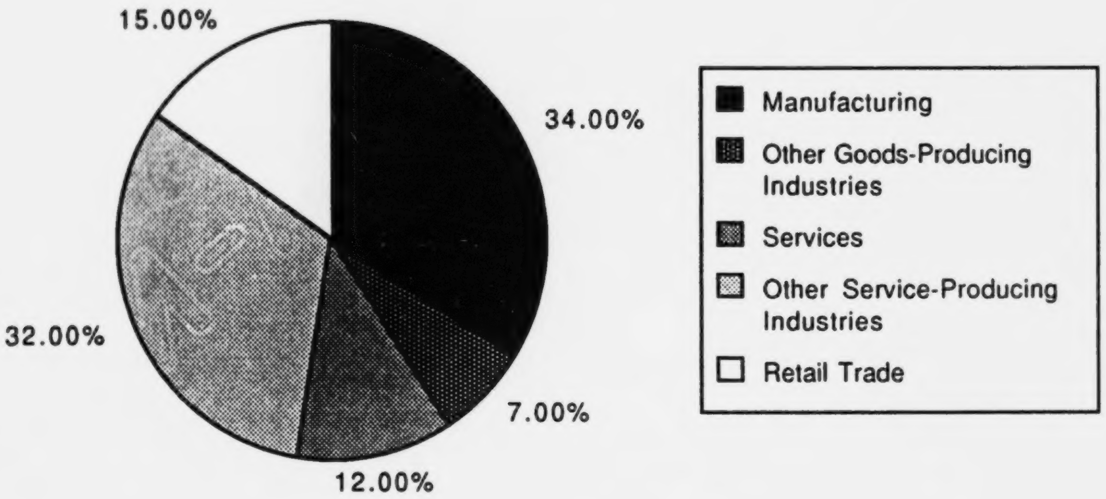
Distribution of Nonagricultural Employment by Industry Groups in 1950 and 1987



Source: *Economic Report of the President*, February 1988, pp. 296-97.

Figure 3b

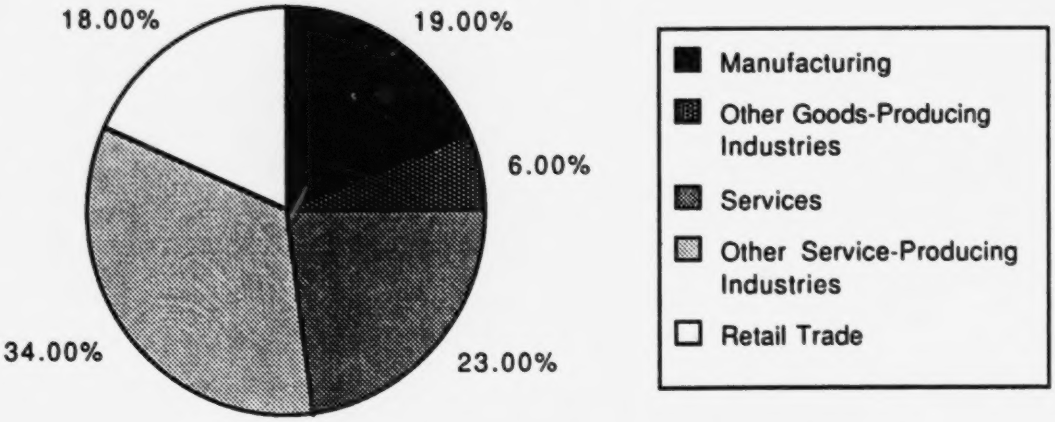
Distribution of Nonagricultural Employment in 1950



Source: *Economic Report of the President*, February 1988, pp. 296-97.

Figure 3c

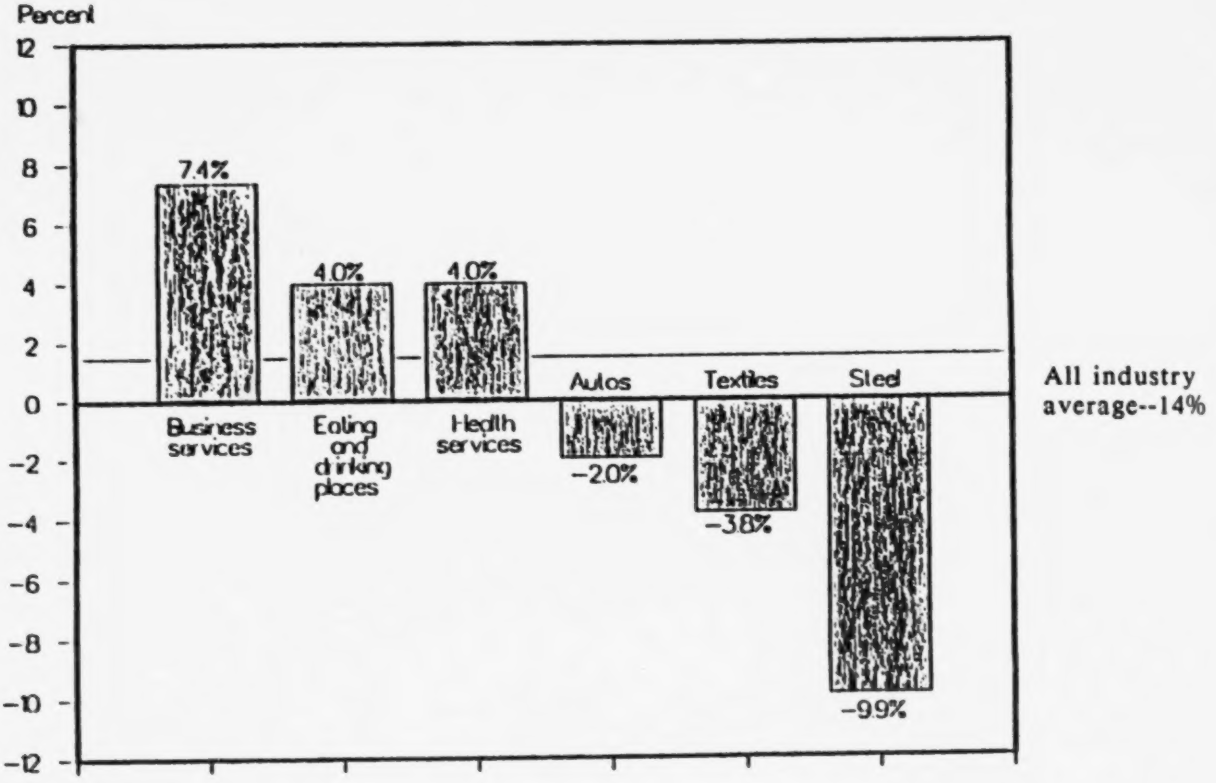
Distribution of Nonagricultural Employment
in 1987



Source: *Economic Report of the President*, February 1988, pp. 296-297.

Figure 4

Average Annual Percent Change in Employment, Selected Industries, 1979-85



Source: Bureau of Labor Statistics, unpublished data.

producer services jobs have grown more rapidly in percentage terms.[63] On net, then, relatively more low-paying, low-skilled jobs have been created in services.

The result of all these changes has been a reduction in middle-level jobs. Services tend to have a more bi-polar occupational distribution (that is, some high-skill jobs, many low-skill jobs and little in between) than manufacturing. Also, the introduction of more automated devices within manufacturing has reduced the demand for many middle-level production worker jobs.

Barry Bluestone and Bennett Harrison have documented that most of the jobs being created by the American economy are in the low-wage categories. Indeed, 44 percent of the net new jobs created between 1974 and 1985 paid poverty-level wages, more than double the rate of low-wage job creation during the 1960s and 1970s. Moreover, the rate of growth in new high-wage professional, technical and managerial jobs was only about one-third of the pace at which jobs were created between 1963 and 1979. Of the 9.3 million new jobs created between 1979 and 1985, 44 percent were low wage (i.e., less than half the 1973 average real wage), while high wage (i.e., those that paid more than twice the 1973 real wage) job growth was only 10 percent of the total. Between 1963 and 1973, less than 20 percent of the 20 million new jobs created were low wage, while almost half were high wage. During the 1973-1979 period, only about 20 percent of the new jobs were low wage, while about 17 percent were high wage. Bluestone and Harrison found that the share of mid-level jobs (paying between $7,000 and $29,600 1986 dollars) nearly doubled from the 1960s to the 1970s, but fell by almost 30 percent during the 1980s. Finally, wage deterioration has not been restricted to any age, sex, or racial category.[64]

A growing reliance on services implies lower wages.[65] In April 1986, for instance, the average manufacturing job paid $393 a week while retail trade paid only $175, and finance, insurance and real estate paid $299 (figure 5).[66]

The decline in productivity growth in the U.S. since the 1960s is a particularly important cause of our loss of competitiveness. With much lower productivity growth than other countries, American companies can achieve competitive unit labor costs only

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[63] For discussion of the service sector, see Thomas M. Stanback, Jr., Peter J. Bearse, Thierry J. Noyelle, and Robert A. Karasek, *Services: The New Economy* (Totowa, NJ: Allenheld, Osmun, and Co., 1981); Thierry J. Noyelle, "Services, Urban Economic Development and Industrial Policy: Some Critical Linkages," presented at a conference on "The Industrial Policy Questions: State and Local Issues," at the University of North Carolina at Chapel Hill, May 1984.

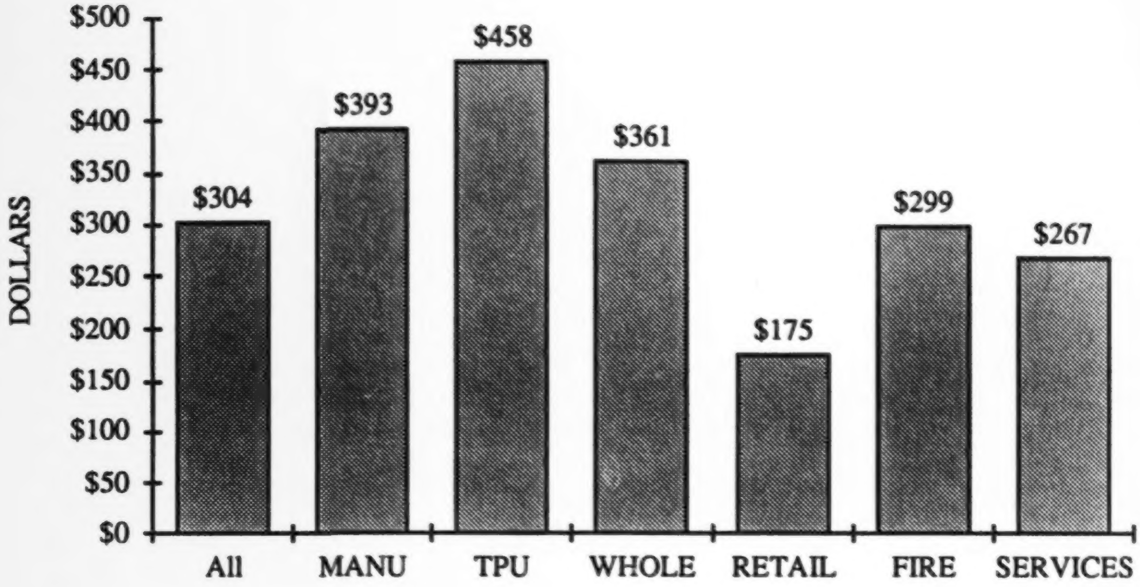
[64] "The Grim Truth About the Job 'Miracle'," *New York Times*, February 1, 1987, p. F-3.

[65] For instance, the American Productivity Center reports that manufacturing productivity grew five times faster than did services' productivity from 1979 to 1983.

[66] Herbert Runyon, "The Service Industries: Employment, Productivity, and Inflation," *Business Economics*, January 1985, pp. 55-63; Bureau of Labor Statistics, "The Employment Situation: April 1986," USDL 86-183, May 2, 1986.

Figure 5

Average Weekly Earnings by Industry



April 6, 1986 Average Weekly Earnings for Major Sectors:

Source: Bureau of Labor Statistics, "The Employment Situation: April, 1986," USDL, 86-183, May 2, 1986.

Note: ALL (all private workers), MANU (manufacturing), TPU (transportation and public utilities), WHOLE (wholesale trade), RETAIL (retail trade), FIRE (finance, insurance, and real estate), and SERVICES (services) by reducing wages (table 2). The combination of low productivity growth and international competition is one of the reasons for declining real wages in the U.S. absolutely and relative to other countries (figure 6). Moreover, American productivity experience is unique. Productivity in other countries recovered much faster from the oil price shocks of the 1970s.

We should note, however, that the U.S. still has the highest average productivity--our problem is that productivity in some other countries is higher in some strategic industries and that the decline in productivity growth makes it more difficult for U.S. companies to improve their real wages and compete in international markets.

Economists do not agree on all of the reasons for declining productivity growth but several aspects of this problem are important for education and labor market policies.

1. More stable economic conditions and more efficient labor market institutions would improve productivity growth.

2. The long run productivity trend has been mainly responsible for higher economic growth, higher standards of living, and more leisure time. Between 1950 and 1980, productivity about doubled in the U.S., despite the slowdown in growth beginning in the 1960s. This long-run increase in productivity has made it possible to reduce the amount of time people spend working. Working hours declined from 53 in 1900 to 35.5 in 1979. In the last 50 years, the number of hours of labor required to produce a product of a given value declined about 3 percent a year, while the number of hours worked declined at about 0.5 percent a year. This does not mean, however, that wages will increase as productivity increases. Moreover, as can be seen from figure 7, there is not necessarily a relationship between relative productivity and relative wages. However, productivity determines the room for wage increases, depending on the degree of competition in product and labor markets.

3. Technology and the quality of labor (i.e., education and health) have been major factors in productivity improvements. Most studies find these factors to have accounted for about three-fourths of productivity improvement since 1929, when we first started keeping such statistics. Physical capital accounts for less than 20 percent.

4. A major productivity problem in the United States appears to be among management and white-collar workers, whose productivity has been declining while that of blue-collar workers continues to increase at about 3 percent a year.[67] Moreover, despite their rapidly growing numbers, information workers have declining productivity growth while that of goods-production workers is increasing. Relative to other countries, especially the Japanese, the work forces in U.S. companies have much larger proportions of managerial, supervisory and white collar workers.

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[67] Lester Thurow, "Review of the *Positive Sum Strategy*," *Scientific American*, vol. 255, no. 3, August 1986, p. 26.

Table 2

Output per Hour, Hourly Compensation, Unit Labor Costs, and Related Measures Manufacturing, 12 countries, 1960-1986

Country	1960-86 (2)	1960-73	1973-86 (2)	1973-79	1979-86 (2)	1985	1986
OUTPUT PER HOUR							
UNITED STATES	2.8	3.2	2.3	1.4	3.1	4.4	3.5
CANADA	3.1	4.5	1.7	2.1	1.4	2.2	-0.5
JAPAN	7.9	10.3	5.6	5.5	5.6	7.3	2.8
BELGIUM	6.4	6.9	5.8	6.2	5.3	2.4	NA
DENMARK	4.5	6.4	2.6	4.2	1.3	-1.4	-0.5
FRANCE	5.3	6.5	4.2	5.0	3.6	3.3	1.9
GERMANY	4.6	5.8	3.5	4.3	2.8	4.4	1.9
ITALY	5.3	7.3	3.3	3.3	3.3	1.5	1.2
NETHERLANDS	6.2	7.4	5.0	5.5	4.4	3.1	NA
NORWAY	3.1	4.3	2.0	2.1	1.9	1.1	-2.5
SWEDEN	4.6	6.4	2.8	2.6	3.0	2.7	1.4
UNITED KINGDOM	3.6	4.3	2.9	1.1	4.4	3.6	2.9
HOURLY COMPENSATION(3): NATIONAL CURRENCY BASIS							
UNITED STATES	6.4	5.0	7.8	9.5	6.3	5.0	2.9
CANADA	8.0	6.2	9.8	11.9	7.9	4.2	3.3
JAPAN	11.7	15.1	8.4	12.8	4.8	4.9	3.5
BELGIUM	10.9	11.0	10.8	14.0	7.7	6.1	NA
DENMARK	11.3	12.2	10.4	14.0	7.4	5.5	4.2
FRANCE	11.8	10.0	13.6	16.3	11.3	6.3	4.4
GERMANY	8.9	10.3	7.4	9.5	5.7	4.7	5.1
ITALY	15.5	13.6	17.4	20.6	14.8	10.4	4.2
NETHERLANDS	10.7	12.9	8.4	11.6	5.2	5.3	NA
NORWAY	10.7	10.0	11.3	13.4	9.6	8.7	7.7
SWEDEN	11.0	10.5	11.5	14.2	9.2	10.1	6.8
UNITED KINGDOM	11.9	9.3	14.6	19.3	10.7	7.1	8.1
HOURLY COMPENSATION(3): U. S. DOLLAR BASIS							
UNITED STATES	6.4	5.0	7.8	9.5	6.3	5.0	2.9
CANADA	6.5	6.0	7.0	9.0	5.3	1.2	1.5
JAPAN	15.0	17.6	12.4	16.9	8.7	4.4	46.6
BELGIUM	10.2	13.2	7.0	19.5	-4.2	3.3	NA
DENMARK	10.6	13.4	7.9	16.6	1.0	3.1	36.4
FRANCE	10.3	10.8	9.8	17.1	3.8	3.4	35.4
GERMANY	11.6	14.3	9.1	16.4	3.2	1.2	42.4
ITALY	11.7	14.2	9.2	13.7	5.6	1.6	33.4
NETHERLANDS	11.3	15.6	6.8	17.8	-3.2	1.8	NA
NORWAY	10.5	11.8	9.2	15.8	3.8	3.2	25.1
SWEDEN	9.7	12.0	7.4	14.5	1.6	5.8	28.9
UNITED KINGDOM	9.1	8.1	10.1	16.4	5.0	4.0	22.2

(Continued on next page)

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(Continued from previous page)

UNIT LABOR COSTS: NATIONAL CURRENCY BASIS

UNITED STATES	3.5	1.8	5.3	8.0	3.0	0.6	-0.6
CANADA	4.7	1.6	7.9	9.7	6.5	1.9	3.8
JAPAN	3.5	4.3	2.7	6.9	-0.8	-2.3	0.7
BELGIUM	4.3	3.8	4.8	7.4	2.3	3.7	NA
DENMARK	6.5	5.5	7.6	9.4	6.0	7.0	4.7
FRANCE	6.1	3.3	9.0	10.7	7.5	2.9	2.4
GERMANY	4.0	4.3	3.8	4.9	2.8	0.3	3.1
ITALY	9.7	5.9	13.7	16.7	11.2	8.8	3.0
NETHERLANDS	4.3	5.2	3.3	5.8	0.8	2.1	NA
NORWAY	7.3	5.4	9.2	11.1	7.6	7.6	10.4
SWEDEN	6.1	3.9	8.4	11.2	6.1	7.3	5.3
UNITED KINGDOM	8.0	4.8	11.4	17.9	6.0	3.4	5.0

UNIT LABOR COSTS: U. S. DOLLAR BASIS

Country	1960-86 (2)	1960-73	1973-86 (2)	1973-79	1979-86 (2)	1985	1986
UNITED STATES	3.5	1.8	5.3	8.0	3.0	0.6	-0.6
CANADA	3.3	1.4	5.2	6.8	3.9	-3.3	2.0
JAPAN	6.6	6.6	6.5	10.8	3.0	-2.7	42.6
BELGIUM	3.6	5.8	1.1	12.5	-9.1	0.9	NA
DENMARK	5.8	6.6	5.1	11.9	-0.3	4.5	37.1
FRANCE	4.7	4.1	5.3	11.5	0.3	0.1	32.8
GERMANY	6.7	8.0	5.4	11.6	0.3	-3.0	39.8
ITALY	6.1	6.4	5.8	10.0	2.3	0.1	31.9
NETHERLANDS	4.8	7.7	1.7	11.7	-7.3	-1.5	NA
NORWAY	7.1	7.2	7.1	13.4	1.9	2.1	28.2
SWEDEN	4.8	5.3	4.4	11.5	-1.4	3.1	27.1
UNITED KINGDOM	5.4	3.7	7.1	15.1	0.4	0.3	18.8

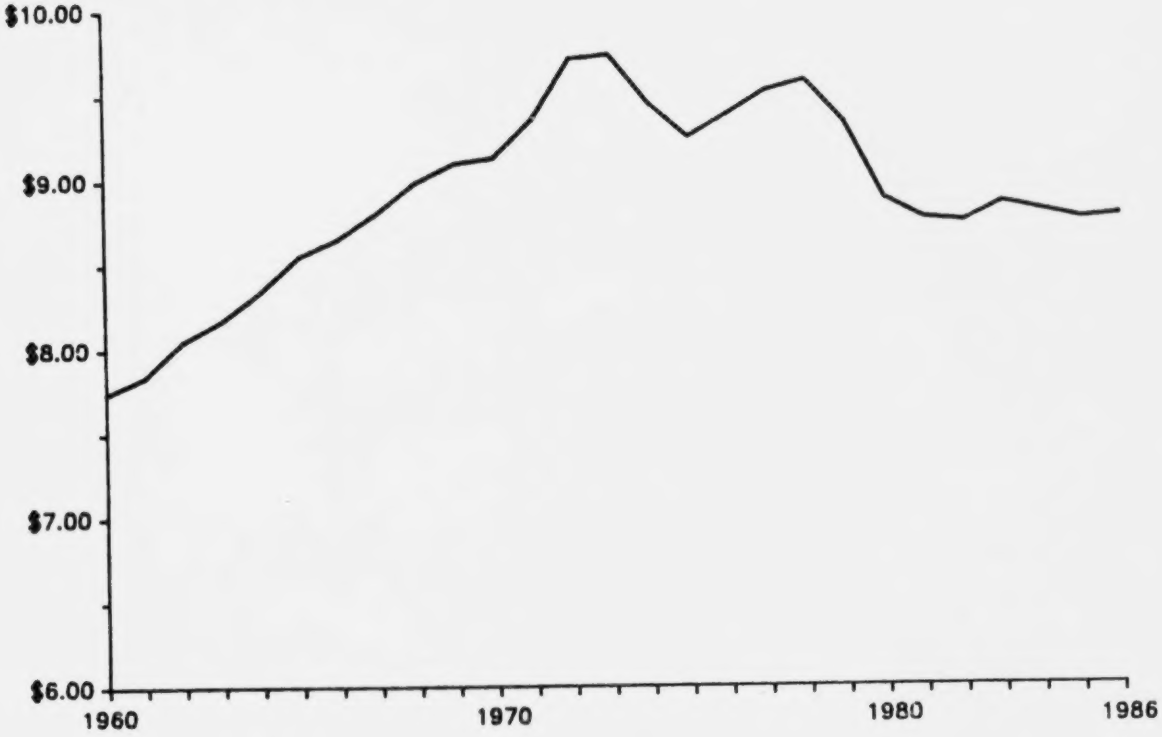
SOURCE: U.S. Depatment of Labor, Bureau of Labor Statistics, unpublished data.

(1) Rates of change based on the compound rate measure.
(2) For Belgium and The Netherlands, data relate to period ending 1985.
(3) Adjusted to include changes in employment taxes that are not compensation to employees, but are labor costs to employers (for France, Sweden and the United Kingdom).

Note: Data relate to all employed persons in the U.S. and Canada. All employees in other countries.

Figure 6

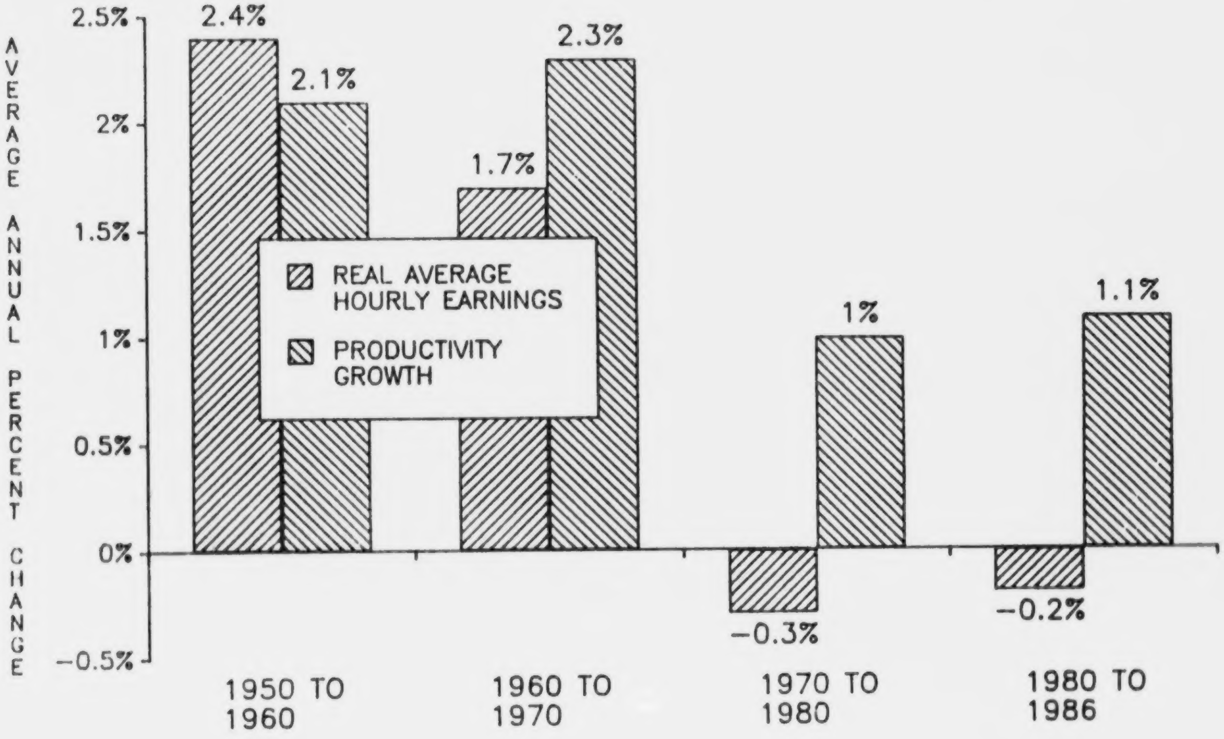
Real Hourly Earnings 1960 to 1986
(in 1986 Dollars)



Source: Bureau of Labor Statistics, unpublished data.

Figure 7

Real Average Hourly Earnings and Productivity Growth
1950s to 1980s



Source: Bureau of Labor Statistics, unpublished data.

Unemployment

As noted earlier, despite more rapid growth of jobs in the U.S than any other major industrial country, job growth has not been enough to keep the unemployment trend from rising, even with a slower rate of increase in the work force.[68] The rate of increase in employment also slowed during the 1980-85 period; the annual rate of increase in employment was only 1.56 percent, one of the lowest for any five-year period since World War II. In addition, periods of unemployment are longer--much longer. During the 1970s the average duration of joblessness was about 11 weeks; during the 1980s it was nearly 16 weeks. And during the 1980s more than twice the number of workers have been unemployed for more than six months than was the case in the late 1960s. In addition, more and more workers are becoming marginal to the work force; they are either unemployed, working part time although they want to work full time,[69] or have dropped out of the labor force because of the lack of employment opportunity.

Unemployment is higher in the U.S. and most European countries because of the shift in policy priorities from keeping unemployment low to fighting inflation--often by deliberately reducing economic growth and creating unemployment. This is, however, an expensive strategy. Unemployment has been particularly serious for young people and minorities. And the social costs of unemployment must be added to the prices of American products. Some countries--Austria, Finland, Iceland, Japan, Norway and Sweden--have elected to keep unemployment much lower than in the U.S. and most of Western Europe. For example, in 1988 unemployment was about 2 percent in Sweden and about 3 percent in Japan.

Income Distribution

Not only have incomes stopped growing, but their distribution has become increasingly unequal. For instance, the lowest 40 percent of the income distribution received 20 percent of the family income in 1967; by 1984, this group had only 15.7 percent, its lowest proportion since 1974.[70] At the same time, the income share of the richest two quintiles increased from 62 to 67 percent, the highest proportion recorded since 1947. In addition, the poorest 20 percent of the income distribution lost 34.3 percent of its real income while the richest 20 percent gained 13.8 percent.

Signs also indicate that the income distribution is becoming bi-polar--to the detriment of the middle class. The share of income received by the middle quintile of families has declined to the lowest level since 1947. Lester Thurow calls the middle class "an endangered species."[71] He also demonstrates that the share of income going to families making between 75 and 125 percent of median household incomes fell from 27 to 23 percent between 1968 and 1983.[72] To Thurow the major reasons for this polarization are clear: the increasing importance of female-headed households, the deskilling of workers, the movement of jobs to nonunion areas and our decreasing international competitiveness.

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[68] The U.S. work force increased about 2.7 percent between 1975 and 1980, and to 1.5 percent in 1980-84. The rates of increase are expected to be 1.3 percent between 1984 and 1990 and 1 percent between 1990 and 1995.

[69] The Bureau of Labor Statistics calls these people employed part time for "economic reasons."

[70] Sheldon Danziger and Peter Gottschalk, "How Have Families with Children Been Faring?" paper prepared for the Joint Economic Committee of the Congress, November 1985.

Frank Levy, one of the country's leading experts on income distribution, also has found growing inequality in income during the 1980s. He has shown that the best way to understand income distribution changes is to track a typical man as he ages from 40 to 50. This typical man experienced an increase in real wages of 36 percent from 1953 to 1963 and 25 percent from 1963 to 1973. In 1973 to 1983, however, this typical man's real income declined by 14 percent.[73] In addition, Levy has shown that average family income distributions became more unequal between 1979 and 1986, despite the fact that there was a slight increase in average family incomes in real terms of $1,000 during this period--to $34,924. For the wealthiest fifth, however, real incomes increased from $70,260 to $76,300, a gain of $6,040. For the poorest fifth, by contrast, average family income *fell* from $8,761 to $8,031.

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[71] Lester C. Thurow, *The Zero-Sum Solution* (New York: Simon and Schuster, 1985), p. 61. Others disagree about the significance of the decline of the middle class. Some argue that the decline is insignificant. Others say that the fall in the share of the middle class is a result of cyclical changes or the entrance into the labor force of inexperienced women and "baby boomers." Harrison, Gorham and Bluestone, op. cit., show that three of the most commonly cited reasons for increasing inequality--the entrance of baby boom workers into the labor force, business cycles, and exchange rate fluctuations--explain only about one-third of the increase in inequality since the late 1960s. On this debate, see Robert Z. Lawrence, *Can America Compete?* (Washington, D.C.: The Brookings Institution, 1984); Sar A. Levitan and Peter E. Carlson, "Middle Class Shrinkage?," *Across the Board*, October 1984; Frank Levy and Richard Michel, "The Economic Future of the Baby Boom," report prepared for the Joint Economic Committee, December 3, 1985; and Neal N. Rosenthal, "The Shrinking Middle Class: Myth or Reality?" *Monthly Labor Review*, March 1985. An excellent review of the issues can be found in Barry Bluestone, "Whither the Middle Class? Labor Market Prospects for the Decade Ahead," presented at the University of Michigan, November 1984 (mimeo). McMahon and Tschetter, in an update and refinement of Rosenthal and others, show that the conclusions reached about this debate depend partly on the technique used. In general, the proportion of employment in higher-paying occupations increased for all groups during 1973-82, but the earnings distribution of these occupations shifted to include more low-paying positions. The data show a distinct disappearing middle for men but not for women. Combining the data therefore tends to be partly offsetting. (Patrick J. McMahon and John M. Tschetter, "The Decline of the Middle Class: A Further Analysis," *Monthly Labor Review*, September 1986, pp. 22-27.

[72] Thurow further argues that (1) between 1976 and 1984 the proportion of middle income male jobs declined from 23.4 percent to 19.7 percent of all male jobs; (2) the percent of income going to the richest 10 percent of American families increased at the expense of those in the range of 20th to 69th percentiles during the period 1969 to 1982; (3) during the 1982 and 1984 recovery the second and third quintiles lost income shares to those above them in the income distribution; and (4) the share of national income going to capital has been rising while labor's share has been falling.

[73] Frank Levy, *Dollars and Dreams: The Changing American Income Distribution* (New York: Basic Books, 1987).

Levy offers several reasons for these changes in average family income distribution.

1. The incomes of men who did not graduate from college have shown a marked deterioration relative to those who did. In the 1970s, a 30-year-old male high-school graduate earned only 15 to 20 percent less than a male college graduate of that age. In 1986 this gap had grown to 49 percent: $26,250 for the college graduate and $17,250 for the high-school graduate.

2. Female-headed households have grown from one-ninth of all families in the early 1970s to one-sixth in 1986; average income for female-headed households was $13,500 in 1986, compared with $39,240 for all families.

3. The tax structure has changed. Levy cites work by Joseph Pechman at Brookings, which shows that during President Reagan's first term, wages and salary income per tax return just kept pace with inflation, rising from $19,127 to $19,186. For the top 1 percent of tax returns, however, income grew from $107,113 to $124,696, or a real gain of 16 percent. Congressional Budget Office studies show that households with an income of $13,000 paid 14 percent of their income in federal taxes.[74]

Given the decline in real income and increasing inequality, it should not be surprising to find that poverty has increased. Although the U.S. made great strides toward reducing poverty in the late 1960s and 1970s, poverty rates have skyrocketed since 1979. Between 1979 and 1983, the poverty rate rose from 11.7 to 15.2 percent, falling only slightly since. Overall, the incidence of poverty in 1984 was about what it was at the outset of the War on Poverty in 1966. Still worse, the poverty rate for vulnerable subgroups was tragically high: blacks (34 percent), youth (21 percent), black youth (47 percent) and Hispanics (28 percent) were the most likely to be poor in 1984.

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[74] Frank Levy, "A Growing Gap Between Rich and Poor," *The New York Times*, May 1, 1988, p. F-3.

Chapter 3

IMPLICATIONS FOR EDUCATION AND LEARNING SYSTEMS

We have noted some implications for education throughout the foregoing discussion of trends and forces affecting the U.S. and world economies. This section analyzes these issues more systematically. It first restates the main orienting hypotheses derived from the trends and forces and then analyzes the evidence with respect to the impact of education and human capital on economic performance.

OVERVIEW

The first major hypothesis is that the internationalization of the American economy and the technological innovations discussed earlier greatly elevate the importance of education in the economy and change the nature of the educational system required for success in a world class system. As will be argued later, in a system where most workers manage information and analytical systems, students must have different skills and knowledge. They must be active learners and problem solvers; they must be able to think for themselves, analyze data, and communicate with precision. They also must have the kind of education that will help them be creative and flexible--i.e., have the ability to adjust to change. They must, in addition, know about other countries, cultures and languages. They must have greater knowledge of their companies and the international and technical environment within which it operates. Workers must also be able to deal with abstractions and manage greater responsibility for their jobs.

The American and other world economies are being transformed from national goods-producing systems based on mass-production technologies to internationalized information systems. The mass-production systems made it possible for people to achieve relatively high incomes with limited levels of formal education because of the economies of scale made possible by the large internal American market and the relative abundance of low-cost natural and energy resources, which were much more important in that production system than they are now. The mass-production system was pioneered in the United States which, until the transportation and communications innovations after World War II, gave American firms considerable monopoly power over certain kinds of production and products. This production system was reinforced by measures to limit labor and product market competition, both of which, by the end of the 1930s, were considered to be excessive in most industrialized democracies. The system was reinforced by oligopolistic and regulated pricing of products and services, relatively fixed wages (through regulations and collective bargaining) and fixed exchange rates. Skill requirements were limited by Taylorism, which sought to reduce the skills needed by workers and to transfer skills and knowledge to machines and to management. Wherever collective bargaining existed it was highly adversarial--partly because of Taylorism and partly because American managers resisted sharing power with their workers. Despite limited skill requirements, the system facilitated increases in productivity, total output and income because of economies of scale, increased education (which also was mass produced), inter-industry shifts (especially out of low-productivity agriculture into high-productivity manufacturing), and improvements in technology within the mass-production system. This system was reinforced after the 1930s by Keynesian monetary-fiscal policies which compensated for the tendency of production to outrun private purchasing power, especially during periods of farm income crises and rising unemployment. In addition to macroeconomic stimulus, other programs were introduced to sustain purchasing power, including unemployment compensation, social security, agricultural price supports, and minimum and prevailing wage legislation.

This system served the U.S. and other industrialized countries well until the 1970s. Indeed, it contributed to the longest period of equitably shared prosperity in our history. It was not necessarily wrong for its time, but many of the institutions supporting it, including the school system, were rendered obsolete by technological change and internationalization. Internationalization requires much greater attention to competitiveness because it is no longer possible to remove a country's production system from competitive forces by regulation and traditional price and wage setting institutions alone. Indeed, oligopolistic pricing and fixed wages made American companies very vulnerable to foreign companies, especially the Japanese, who stabilized employment and output and used flexible prices to increase long-run market share.

The implications of internationalization for workplace skills depend critically on the definition of competitiveness. In an economic sense, competitive markets will always clear and balance because prices will fall to make it possible for supplies to adjust to demand. However, unless they have large productivity advantages, this definition implies declining standards of living for high-wage countries like the United States. The fundamental competitiveness question is, How can American companies compete in the U.S. and foreign markets on terms that will make it possible for Americans (or Texans) to maintain or improve their incomes? If incomes are ignored, there is no competitiveness problem--we can reduce our wages and prices (i.e., our standard of living) enough to sell all of our output. In technical terms we can compete by worsening terms of trade, as we did all during the 1970s, even though our trade appeared to be balanced. We were giving up more in real terms to pay for our imports. During the first half of the 1980s, we not only continued to give up more in real terms, but incurred rising net foreign debts as well. At the end of 1985, foreigners owed Americans about $989 per American worker; by the beginning of 1987, Americans owed foreigners about $2,500 per American worker. Per-worker federal debt to all sources increased from $6,730 to $16,562. Heavy borrowing from foreigners and depletion of our physical capital made it possible for Americans to increase per-worker real consumption between 1980 and 1986 by $3,100 while production increased by only $950; the other $2,150 was financed by disinvesting and borrowing.[75]

If we assume supportive, or at least neutral, public policies are in place, we can either compete by lowering our standard of living or paying more attention to the kind of competitiveness that will make it possible for us to maintain or improve our real incomes. In general, companies and institutions will be required to give greater attention to productivity, quality, efficiency (i.e., *costs*, not just physical productivity) and flexibility. These outcomes can be achieved mainly by using leading-edge (not standardized) technology. The development and use of the technology depends, in turn, mainly on the quality of the work force.

There are, unfortunately, no unambiguous measures of work-force quality. One common measure is average number of years of schooling, in which the United States ranks higher than any other country. But for a variety of reasons schooling is not a very good indicator of the quality of a country's work force. First, not all years of schooling are equal. The U.S. has a relatively short school day and the shortest school year of any major industrial country (175 days versus 249 in Japan). In fact, the typical Japanese high school graduate has the equivalent of four more years of actual class time than the typical American high school graduate. Second, time spent in school yields different levels of productivity in terms of educational achievement. Third, as we shall see, only a relatively small part of a person's income-earning knowledge and skill is learned in school. Most learning is done before a person starts to school through community and family associations, through the mass media, and on the job. Because of the synergistic relationships between workers and technology, workers learn a lot using and developing advanced technologies. Since the U.S. has a substantial (but diminishing) technological lead over all other countries, we probably have the highest average quality work force. Until we find a better measure, productivity is probably the best proxy for work-force quality. And, as noted earlier, the United States has the highest average level of productivity--though here, too, we are rapidly losing our lead. Some experts argue that the United States has the highest upper half of its work force of any country, but a poorer bottom half than any of our major competitors.

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[75] Peter G. Peterson, "The Morning After," *Atlantic, vol. 260, no. 4,* October 1987, p. 47.

A major indicator of poor work force quality are lower levels of literacy than most of our competitors. About 13 percent of U.S. adults are illiterate in English. Between 17 and 21 million Americans have trouble reading an employment notice, filling out an application, or understanding written instructions. Indeed, even some Third World countries have better performance on some indicators than the United States. I have even been told that some Japanese employers assume that production workers they hire in the United States will have education characteristics more like those of Third World than Japanese workers.

This judgment would seem to be confirmed by the 1986 National Assessment of Educational Progress (NAEP).[76] While this report found that 95 percent of young adults reach or surpass a fourth-grade reading level (the standard of literacy adopted by the military almost 50 years ago), this standard was grossly inadequate for modern labor market requirements. For example, only 20 percent of young adults with high school education or more could write a decent letter, only 12 percent could arrange common fractions in size order, only 4.9 percent could decipher a bus or train schedule, and less than 20 percent could determine the amount of a tip, given the percentage of a bill.

International Comparisons

The correlations between behavior and achievement scores have caused widespread concern, not only about the long-run decline in test scores by American students, but also about their low standing on international tests. Analyzing data from the International Association for the Evaluation of Educational Achievement (IAEEA), Lerner found the mean scores of U.S. 18-year-old high school seniors to be in the bottom half of rank order scores 13 times and in the top half only 6. American students ranked particularly low in mathematics and some science tests.[77] Data from the Second International Science Study, released in 1987, comparing U.S. and foreign students, concluded from assessments in 1970, 1983-84, and 1986 that the science achievements of American students had improved little over the past two decades and still lagged far behind those of students in other countries.[78] Herbert Walberg reached similar conclusions:

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[76] Irwin S. Kirsh and Ann Jungeblut, *Literacy: A Profile of America's Young Adults* (Princeton, NJ: The Education Testing Service, 1987).

> Test scores [of American students] in science and mathematics of a decade or two ago compared unfavorably with those of youth in other industrialized countries, and, since that time, have declined substantially. . .about 20 percent of all American seventeen year olds were verbally illiterate in 1975.[79]

The preliminary results of the Second International Science Study found that U.S. students lagged far behind those of other countries in science achievement (table 3). Moreover, despite slight improvements in 1983, American student achievement in 1986 was at or below the level attained in 1970 when the first international study was conducted.

Table 3

1986 Scores from the Second International Science Study

	% Correct	
	Physics	Biology
Japan	71	59
England	48	58
U.S. I (1st year students)	34	34
U.S. II (2nd year students)	44	44
Composite (nine countries)	62	51

Source: Robert Rothman, "Foreigners Outpace American Students in Science," *Education Week*, January 28, 1987, p. 1.

U.S. students not taking science performed somewhat better relatively, but still lagged behind the nine-country international average; the Americans averaged 48 percent correct; the international average was 56 percent. The Japanese and English nonscience students had scores of 58 and 60, respectively.[80]

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[77] Barbara Lerner, "American Education: How Are We Doing?" *Public Interest*, Fall 1982, pp. 59-82.

[78] Robert Rothman, "Foreigners Outpace American Students in Science," *Education Week*, January 28, 1987, p. 1.

[79] Herbert J. Walberg, "Scientific Literacy and Economic Productivity in International Perspective," *Daedalus*, vol. 112, no. 2, Spring 1983, pp. 1-28.

The latest international comparisons in science achievement tests rank American fifth graders eighth behind the leaders, Korea and Japan. American ninth graders ranked fifteenth out of sixteen, tied with Singapore and Thailand, and slightly ahead of Hong Kong.[81]

Some disagreement arises concerning the reasons for these test score differentials. Walberg attributes part of the difference to the higher proportion of American students in the age group enrolled in school. Lerner disagrees, arguing that enrollment differences are not very important since there also are differences (though usually smaller) at lower ages where enrollment rates are very similar among the industrial countries. Lerner contends that four variables account for these cross-national differences: amount of time spent on homework, amount of class time spent on relevant school work, frequency of class attendance and the demands placed on the students by their texts. That hard work and not enrollment levels was the critical factor is suggested by the experience of Japanese students, whose enrollment rates are about as high as the U.S., but who have top achievement levels on test scores and much lower dropout rates than the U.S. Inkeles analyzed the IAEEA studies and also concluded that the main factor accounting for differences in test scores was time spent on a subject. He also found that socioeconomic background accounted for only 20 percent of the variance in test scores, and that differences in school qualities account for as much of the variance as home background, age, and sex taken together.[82]

Thus, if the assumption that competitiveness depends heavily on the quality of the work force is correct and if the quality of the work force depends in part on the level of education, the United States clearly has some serious problems. Moreover, since Texas's education accomplishments are even lower than those of the United States, we have an even more serious problem. As noted in the discussion of technology and deskilling, however, not all experts agree that higher levels of education will be required for the work force of the future. I conclude that more and different kinds of education will be required if we want to be a high-income, world-class economy. Since the conclusion that more and different kinds of education will be required also is a controversial premise, and since this assumption is so important to conclusions about the need for school reform and greatly improved education achievement, the evidence for this conclusion should be explored at greater depth. This evidence will be presented after I outline some major hypotheses about what a world-class education system could be like.

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[80] Rothman, "Foreigners Outpace American Students," p. 1.

[81] W.J. Jacobson, R.L. Doran, E. Humrich, and E.B. Konis, *International Science Report Card*, Second IEA Study (New York: Columbia University Teachers College, 1988).

[82] Alex Inkeles, "The International Evaluation of Educational Achievement: A Review of International Studies in Evaluation," *Proceedings of the National Academy of Education*, vol. 4, 1987.

Education and Technology Assumptions

One of the major purposes of this PRP is to assess the use of technology for improving the efficiency of Texas public schools. One orienting hypothesis, therefore, is that technology can improve both the learning opportunities for students and the administration of the schools. Both of these goals are extremely important. I have noted that students will have to know more, and, in order to be world class, the school systems will have to be reformed in important ways. Reforming the schools assumes, however, that adequate resources will require the freeing of existing resources by improving productivity. More resources probably will be required but these are not likely to be forthcoming unless school systems are able to demonstrate greater efficiency in the use of the resources they already have.

I assume, in addition, that technology must be integrated into school administration and student learning processes--it cannot simply be added on. In other words, school systems should strive to achieve organic relationships between learning systems and technologies, not artificial transplants that these systems will reject. In order to use the technology most effectively in school settings, there must be a period of trial and error and experimentation in each place. Teachers and students--with expert outside assistance--must be involved in order to effectively integrate the technology into each system and each classroom.

Many similarities and differences exist between the use of technology in the work place and in the schools. Indeed, many of the problems are the same, especially the need for systemic change. A basic economic problem is to transform economic institutions and policies designed for mass production systems geared to national markets and deemphasizing competitiveness (i.e., productivity, economic efficiency, quality, and flexibility) into ones that are competitive on a global basis.

Since early school management systems were modeled after early factories and were designed to serve the needs of a goods-producing economy, they face the same problems. They not only must prepare students for the international information world, but also most change their management systems to pay more attention to productivity, efficiency, quality (excellence), and flexibility. Efficiency requires greater attention to the relationships between inputs and outputs. In particular, policymakers and administrators must see to it that school systems' incentives are to produce the desired outcomes in an efficient manner.

In all of these things, technology has an important role to play. Effectively integrated into a school system, technology has the potential to improve teaching and learning. Technology can pinpoint the learning processes of individuals, track learning pathologies with greater precision, and make more accurate, realistic, and effective information and learning materials available to students and teachers. Technology can improve group as well as individual instruction. Computers and telecommunications probably will dramatically change the delivery of learning services to students and teachers. Technology makes it possible for the school of the future to establish learning centers with user-friendly computers and software programs, telecommunications-networked computers, and previously undreamed of database information libraries. Retrieving and assembling the appropriate facts to understand

and solve problems will require students to learn analytical methods that are part of analytical reasoning, or what some authorities call higher order thinking.[83]

It should be emphasized, however, that the best use of technology will not replace teachers. In the immediate future computers can reduce the time teachers spend in such routine tasks as grading papers, calculating grades and writing reports. The use of information technology will make it possible for teachers to more effectively meet the individual students' learning needs. If technology takes over many routine tasks, teachers can spend more time facilitating learning and motivating students.

In short, technology is a tool in the learning process. Careful attention should therefore be given to the appropriate systems to make the best use of this tool. A good working hypothesis is that technology will reflect the systems using it--making bad systems worse or greatly improving good systems. The discovery made by the chairman of General Motors about the use of technology in his company is equally applicable to schools: if you do not pay attention to production systems before the technology is introduced, you probably will merely pile up scrap faster.

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[83] A good analysis of the kind of higher order thinking skills more workers will be required to have is provided by Lauren Resnick, a cognitive psychologist at the University of Pittsburgh. According to Resnick, higher order thinking

- is *nonalgorithmic*--the course of action is not fully specified in advance
- *complex*--the whole process is not mentally visible from any single vantage point
- often yields *multiple* rather than single solutions
- involves *nuanced judgments and interpretations*
- involves the application of *multiple and sometimes conflicting criteria*
- involves *uncertainty*, because everything related to the task is not known in advance
- involves *self-regulation* of the thinking process rather than control by others
- requires *imposed meanings* by finding patterns or structure in apparent disorder
- requires effort

Resnick argues that there have been two different traditions in the American school system: one for the masses and the other for the elites. The elite system involves higher order thinking. She argues: "Although it is not new to include thinking, problem solving, and reasoning in someone's curriculum, it is new to include it in everyone's curriculum. (Lauren Resnick, *Education and Learning to Think*, Washington, D.C.: National Academy Press, 1987, p. 7). "Not only must higher order thinking skills be embedded in all school learning processes, but they can take place at every level of schooling. Indeed, the thinking of preschool children is of a higher order than that which takes place in a typical elementary or secondary public school.

Resnick, in her 1987 presidential address to the American Education Association, outlines four important ways school-based learning differs from the learning that goes on outside of schools, especially on the job. Most on-the-job learning (OJL) is in a group setting, while the schools emphasize individual competition; schools stress "pure mentation," while OJL involves the use of tools; the symbols used in school often lose their connection with the things and events being symbolized, while in OJL the symbols *must* reflect accurately the underlying events or they could lead to serious error. Academics defend abstract learning on the grounds that to be useful theories must abstract from reality in order to avoid being too cumbersome. They forget, however, that abstractions that do not reflect basic and causal relationships are not very useful for public or private policy decisions. (Lauren Resnick, "Learning in School and Out," Presidential Address, American Educational Research Association, Washington, D.C., April 22, 1987.

The school systems to use this technology must reflect the transitory nature of modern societies, in Texas as in the nation. As noted, this will be a society of change. More and more students will come from single-parent families or situations in which both parents work, requiring more pre-school and after-school programs. More of these students will need special language, academic, and counseling services.

Learning

Clearly, learning is one of the most (if not the most) important human activities. It comes as something of a suprise, therefore, to discover that scholars have devoted surprisingly little attention to learning. They apparently assumed that since learning is so pervasive and important in a person's life, everyone knows what it is or at least how to do it. As learning has become such a critical factor to personal, business, and national success in knowledge-based societies, corporate education centers have done considerable research into cognitive as well as effective learning processes. Software companies have spent large amounts of money investigating human learning patterns. Computers have opened a whole new vista in these inquiries by making it possible to track individual learning processes, patterns, and pathologies. Indeed, Eurich argues that "New insights into the educational process are coming from corporate classrooms--not from colleges and universities. Higher education has done little to learn about teaching and learning. The university's instructional mode has scarcely changed over the past 50 years. Educational innovations are few and often of only marginal impact."[84] A major reason for this state of affairs, according to Eurich, is the fact that universities, unlike progressive businesses, do not improve their performance by innovative research and development. She continues, "Seldom has interest in the learning process, its differences among individuals, and the implications for classroom methods been expressed in educational halls, much less supported and rewarded."[85] By contrast, the federal government, especially the departments of Defense and Labor, have sponsored and undertaken considerable research on learning processes.

Project 2061, sponsored by the American Association for the Advancement of Science, has brought together teachers, administrators, scientists and technical experts to specify what secondary school students should be taught about science and technology. This project has, in addition, summarized some principles that flow from research on learning.[86]

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[84] Nell P. Eurich, *Corporate Classrooms* (Washington, D.C.: The Carnegie Foundation for the Advancement of Teaching, 1985), pp. 55-56.

[85] Ibid., p. 56.

[86] The following paragraphs come from a discussion paper on learning produced for Project 2061. The final report of the project will be published in 1988.

The first principle from this research is that to be meaningful, ideas must be internalized to the learner. Concepts are learned best if they "are experienced in a variety of contexts, and experienced in a variety of ways." Moreover, ideas must "have multiple connections into how students must restructure their thinking." Students must, in short, find the new idea "to be more personally satisfying in making sense of the world."

Second, learning ordinarily moves from concrete, tangible and directly accessible realities to abstract ideas. Abstract ideas are increasingly important in an internationalized information world but few children enter the world loving abstractions. "With maturity, experience, and practice," students "grow in their ability to understand abstract concepts, to manipulate symbols, and to reason logically." Science itself matches the learning process as it proceeds from concrete facts to abstract concepts and back to facts again to constantly test generalizations. Unfortunately, many teachers undermine effective learning byoverestimating their students' ability to handle abstractions.

Third, learning involves the unity of thought and action. We learn what we practice. If we want students to learn to deal with change, they must practice solving problems by applying ideas to new and changing situations. "If they practice only plugging in answers to predicatable exercises, then that is all they are likely to learn." People must, in other words, really learn things by repitition and practice in realistic settings.

Fourth, learning requires more than repitition; to be effective, learning requires constant and thoughtful feedback. Feedback must not merely be designed to provide "the right answers." It must be "analytical, suggestive, and come at a time when the student is interested in it. And then there must be a time for a student to reflect on the feedback, to make adjustments and try again--a requirement violated by most examinations, especially 'finals.'"

According to Project 2061, several principles for teaching science, mathematics, and technology flow from these observations:

1. Learning these subjects should be active and participatory. Not bookish.

2. Teaching should build on the experiences and events that are real to young people.

3. Teaching and learning take time.

4. Teaching should strive to foster curiosity, imagination, and creativity.

5. Healthy skepticism should pervade teaching and learning. "Dogmatism. . .militates against the questioning attitude, and thus has no legitimate place in the classroom."

6. Learning should often be in groups. "Overemphasis on competition among individual students for high grades distorts what ought to be the prime motive for all science--finding things out, and for technology--getting things done."

7. Students can learn something about a subject. "More important than what level of sophistication individual students reach during the school years, is what they come

away with in the way of familiarity, with how science sees the world, with self-confidence in their ability to learn. . .and with an inclination to learn more."

Thus, in a more dynamic and competitive world, schools, like companies, must evolve from those required for mass-production systems. They must teach individual students, not textbooks, thinking rather than memory skills, and learning skills rather than test-taking techniques. Indeed, the kinds of tests we give students and teachers will drive the education system. We do not teach people to think by giving true-false or multiple-choice tests.

Working Hypotheses

Some hypotheses about changes that must take place if we want to have world-class learning systems include:

1. Students will be active learners, not just absorbers of facts and knowledge.

2. The curricula will shift their focus from the basic skills required for the 20th century to the high-level skills required for the 21st century. Greater emphasis will be placed on integrated knowledge rather than subject-by-subject treatment.

3. Greater attention will be given to language and international studies.

4. Instead of teaching confined to or centered on textbooks, more diverse curricula will be tailored to individual learning needs. The concept of grouping students according to grade levels will tend to give way to groupings according to common learning experiences.

5. More systematic learning will take place in communities and outside of classrooms. Students will be given more help to see the relationship between schools and the real world. School administrators will seek to create incentive systems for students and teachers that tie success in school to success in higher education and in the work place.

6. Incentives will be created to actively involve parents and nonparent adults in the public schools.

7. Individual schools and their teachers and students will have more control over the education process. In addition, more rigorous school-based accountability systems that will seek to provide fair, equitable and objective methods to evaluate the performance of students, teachers and schools will be used. As a result, much greater attention to measurement and testing will be required.

8. Incentives will be created to attract good teachers and keep them in the classroom.

9. The necessary restructuring of the schools will require a lengthening of the school day and the school year while providing greater flexibility in accommodating the schedules of students and parents. Children will start systematic learning much earlier and day-care programs will become more universal and have much more learning content.

10. Schools will benefit greatly by more student and parent involvement with teachers, administrators, and community leaders in goal setting, consensus building, and information sharing. Parents will continue to have fewer children and be much more concerned about their intellectual as well as their physical development. Schools will increasingly serve adult and community needs as well as those of their students.

11. Information technology will greatly improve the efficiency of learning and will become an integral part of the learning process, breaking down the dichotomy between vocational and academic subjects at every level, although there will be a tendency for more specialized, job-oriented subjects to be taught in the later years of high school. High school, technical schools, and community colleges will be melded, with more high-school students taking technical courses in these post-secondary institutions, which are better suited to provide such courses.

12. Since information technology loosens geographic constraints on distance learning, it will greatly improve the educational services of rural schools and decentralize the delivery of educational services. In fact, learning technology will cause education to increasingly be thought of as a process, not a place.

13. The status and importance of public schools will rise and their organization and functions will change dramatically. An alternative hypothesis could be that the public schools become increasingly institutions for black, brown and poor students while the more affluent send their children to private schools. If this happens, instead of serving as unifying forces, these schools will perpetuate the growing balkanization of the American population that has been going on since World War II, which was the country's last unifying experience.

14. Much greater flexibility in the delivery of learning services to students in post-secondary technical programs will be developed. Classes will be less standardized, permitting more self-paced instruction and performance-based testing. Workers will "graduate" all during the year, as they now do in the Job Corps.

15. Educational equity for minorities will become a much more important policy issue, requiring a shift of education resources to overcome the learning problems of these groups, particularly Hispanics, Alaska natives, and blacks. Learning technology will make it possible to close the achievement gaps. Much greater attention will be given to the recruitment of minority teachers and administrators. This problem is sufficiently serious that educational equity will become a major success criterion for evaluating schools and school officials.

16. Business enterprises and community groups will give much greater attention to education as human resource development becomes a more important business necessity, the schools become more vital institutions in society, and learning is no longer restricted to traditional classroom settings.

As noted, these are more hypotheses than hard answers. Much more needs to be learned before we can conclude that these hypotheses provide the factual and analytical bases to achieve a world-class education system. These hypotheses are based on one vision of what such a system would be like. Another, and I think very good, vision, used as the basis of the Carnegie Task Force on Teaching's initial work, is contained in appendix A. It should be emphasized, however, that these visions are mainly to evoke discussion; they are not blueprints for action. In order to test these ideas, specific guides must be developed to be applied in particular places. The following sections of the paper explore the evidence for the proposition that world class economies require world-class education systems.

THE RELATIONSHIP OF HUMAN RESOURCE DEVELOPMENT TO ECONOMIC PERFORMANCE: EVIDENCE AND ISSUES

This section examines in greater depth the evidence relating to the impact of education on various economic outcomes. Of particular interest are causes of the relationship between education and various outcomes, especially income and employment. We should note, however, that little dispute arises about the facts: clear individual and national associations between education and income are evident. But the basic issue is over cause and effect (i.e., whether or not the higher levels of education caused the higher income or whether higher incomes caused higher levels of education). Clearly this is an important issue.

One important fact discussed above was the dramatic growth during the 1980s in the relative earnings gap between college and high-school graduates. We also noted the assumption from the Hudson Institute study by William Johnston that the new jobs being created in the future would require higher levels of education, assuming those jobs would require the same levels of education as similar jobs now require. This is an important assumption but is hardly proof that those jobs will in fact require more education.

The gross impact of education on earnings can be seen by comparing the earnings of 20-to-24-year-old, out-of-school males in real (1984) dollars by level of education (table 4).

Table 4

Earnings of 20-to-24-Year-Old, Out-of-School Males

	Real Mean Earnings		% Change in Earnings, 1973-74			
	All 20-24-Year-Old Males		All	White	Black	Hispanic
Level of Education	1973	1984				
No diploma	$11,210	$ 6,552	-41.6	-38.7	-61.3	-38.6
High school grad.	14,342	10,020	-30.1	-26.1	-52.2	-28.1
College graduate	13,443	12,443	-11.0	-12.2	+16.3	-14.9

Source: *Current Population Survey* public use tapes, March 1974 and March 1985 ; calculations by Center for Labor Market Studies, Northeastern University; Gordon Berlin and Andrew Sum, *Toward a More Perfect Union* (New York: Ford Foundation, 1988), p. 9.

As these data show, income generally rises with level of education and the income losses between 1973 and 1984 were less for those young males aged 20 to 24 who had high levels of education. Note also that in 1973 high school graduates actually had higher average earnings than college graduates but that this relationship had reversed by 1984. Except for black male college graduates, the only group to experience higher incomes (16.3 percent) in 1984 than in 1973, the losses were generally higher for blacks and Hispanics (table 5).

Table 5

Education, Unemployment, and Poverty, 1987

Education Level	% of Population 25 and over	Unemployment, Workers 25-64*		Families in Poverty*
		M	F	
4+ years of college	19.4	2.5%	2.1%	NA
1-3 years of college	16.9	5.0	4.0	4.0
High school: 4 years	38.4	6.7	5.8	9.5
High school: less than 4 years	11.9	11.2	10.9	18.5
Total		6.0	5.2	10.9

Source: *Statistical Abstract of the U.S. 1988*, Tables 202, 634; data for older workers from Bureau of Labor Statistics, July 1988.

* These figures are from March 1987.

As can be seen in Table 5, the incidences of both unemployment and poverty are lower for people with higher levels of education. But to what extent are these differences causally related? The remainer of this section is an attempt to answer that question. Evidence with respect to the overall impact of human capital formation (of which education is a major component) and education on economic growth is reviewed. This is followed by discussions of the returns to investments in human capital and the impact of human capital on individual and corporate productivity and incomes follow. The evidence with respect to whether or how schools can be changed to improve educational achievement is reviewed in the next section.

Before proceeding, however, we should recall the distinction between *education* (higher skills and knowledge, or what some analysts believe measure the "quality of schooling") from *schooling*. Schooling refers to time spent in school and *education* refers to the attainment of skills and knowledge. Early studies measuring the relationship between schooling and various social outcomes found very weak relationships, especially when family incomes were controlled for. By contrast, studies that measure the relationship between basic educational skills or competencies regardless of years of schooling, have found strong positive relationships with various economic and social indexes. For example, Berlin and Sum[87] have compiled evidence that individuals with basic skills do better in school work, have higher self-esteem, and are more likely to complete additional years of school, obtain a high school diploma, go on to college, complete college, work more hours, earn higher wages, enter into marriage, and be more productive workers. At the same time, those without good basic skills "will more likely be school dropouts, teenage parents, welfare dependent, or criminally involved."[88]

Education, Productivity and Economic Development

Just as an individual's income and quality of life improve with added investment in human capital, so too, many have argued, human resource development has a major influence on the income and quality of life of the entire society. Logically, human resource development is important to economic performance and competitiveness because all the keys to competitiveness--efficiency, quality, flexibility, and innovation--depend on well-educated, well-trained people. Countries with limited physical resources, like Germany and Japan, have enjoyed superior economic performance because they have been forced to develop their human resources. Indeed, Pacific Rim countries like Korea, Taiwan, and Singapore have given very high priority to education and human resources as a means of leapfrogging the competitive process. According to Lew Branscomb, former chief scientist at IBM Corporation, that company's best educated work force is in Korea and, according to some estimates, in 1987 the literacy rate in Korea--generally classified as a developing or newly industrializing country--was higher than in the United States. Korean policymakers seem to understand, perhaps better than those in the United States, that people are the active agents of development. Thus, it can be argued that developed people are an almost unlimited asset; undeveloped people can be a serious liability to a society.

What is the evidence for the causal relationship between education and productivity growth? Despite the general preoccupation of many economists with financial affairs and physical capital, a growing body of evidence demonstrates that knowledge, the advancement of technology, and improvements in the quality of human resources are the main sources of economic growth and productivity. On the basis of reviews of several studies, Carnevale concluded that:

> People, not machines, are the well-spring of productivity. Since 1929, growth in on-the-job know-how, the reallocation of labor through retraining, and increased labor quality through education, training and health care consistently have accounted for more than three-quarters of productivity improvements and most of our growth in national

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[87] Gordon Berlin and Andrew Sum, "American Standards of Living, Family Welfare and the Basic Skills Crisis," speech delivered at a conference of School and Employment and Training Officials, sponsored by the National Governors Association and the Chief State School Officers, December 1986, p. 2. See also, Berlin and Sum, 1988, *Toward a More Perfect Union.*

[88] Berlin and Sum, "American Standards of Living," p. 2.

> income. By comparison, over the same period, machine capital has contributed a consistent and disappointing 20 percent or less.[89]

Dennison reached similar conclusions in a study for the Brookings Institution. Others have made the point that human resource development has always been a major determinant of economic development.[90]

Both logic and empirical evidence suggest an increasingly important relationship between economic performance and the quality of the work force. Logic suggests that the quality of human resources--knowledge, skills, health, and motivation--is a critical determinant of the ability of any group to be productive (i.e., to produce more with the same or fewer resources). Well-educated, healthy, highly motivated people can, in addition, put together the policies and institutions to solve their problems and meet their objectives. Logic also suggests that as technological innovation becomes a more important determinant of national and individual welfare, education probably becomes even more important. Most workers today handle information--they are knowledge workers. As this technology becomes more pervasive, people who want to improve their incomes and productivity must understand and be able to use leading-edge technologies.

As noted, however, considerable controversy arises over the relationship between education or schooling and productivity, growth, and individual incomes. An exploration of this controversy reveals much about the linkages between education and economic performance, as well as about the technical difficulties involved in disentangling these complex relationships. Such an exploration should, in addition, strengthen our critical and analytical skills and help us avoid some typical logical errors in the education policy debates.

Much of the early economic research on education and "human capital" was stimulated by Theodore Schultz's pioneering studies, for which he was awarded the Nobel Prize in economics.[91] Schultz, an agricultural and development economist, believes that much of what really matters about economics would be learned if we could explain why people are poor. In his view, the main causes of human poverty have less to do with availability of land and physical resources than assumed by most development experts of the 1950s and 1960s, when he was doing his seminal work. "The decisive factors of production in improving the welfare of poor people are not space, energy and cropland; the decisive factors are the improvement in population quality and advances in knowledge."[92] Schultz therefore challenges the neo-Malthusian view that it would be impossible to produce enough food for the growing world population. He believes that educated, healthy, motivated people have been able to overcome physical resource constraints. He points to the evidence from agriculture, in which research has greatly improved productivity by substituting knowledge for land. Indeed, despite great increases in total output, no net additions of physical resources to American agriculture have occurred since 1925. "The substitution process is well illustrated by corn: the corn acreage in the United States in 1979, 33 million acres less than in 1932, produced 7.6 billion bushels, three times the amount produced in 1932."[93] Schultz also cites evidence from the developing countries to show that where human capital investments have been made they "have been successful in improving economic prospects wherever they have not been dissipated by political instability."[94] By political instability he includes incompetence and poor policies that create disincentives for the poor to improve their conditions. Indeed, Schultz hypothesizes that the returns to population quality (i.e., investments in health, child care, and schooling) are increasing over time. He also argues that many countries make a serious policy error by treating investments in schooling as current outlays or consumption expenditures instead of investments.[95] The classical economists, along with many contemporary demographers, failed to recognize either that parents would substitute quality for quantity or that researchers would find substitutes for cropland in producing food. In other words, the classicists and the neo-Malthusians have a quantity rather than a quality theory of population.

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[89] Anthony Carnevale, *Human Capital: A High Yield Corporate Investment* (Washington, D.C.: American Society for Training and Development, 1983), pp. 8-9.

[90] Edward Dennison, *Trends in American Economic Growth: 1929-1982* (Washington, D.C.: The Brookings Institution, 1985); Frederick Harbison, *Human Resources as a Wealth of Nations* (New York: Oxford University Press, 1973); Frederick Harbison and Charles Myers, *Education, Manpower, and Economic Growth* (New York: McGraw-Hill, 1964); Theodore W. Schultz, *Investing in People: The Economics of Population Quality* (Berkeley: The University of California Press, 1981).

[91] Theodore W. Schultz, *Investing in Human Capital* (New York: The Free Press, 1971); and Schultz, *Investing in People.*

Human capital improvements are particularly important in creating entrepreneurship or improving the ability of people "to perceive, interpret, and respond to new events in a context of risk" and "adjusting to the disequilibrium inherent in the process of modernization."[96]

One of the paradoxes examined by Schultz is the finding that "the rate of return on investment in human capital has tended to exceed the rate of return on physical capital." This paradox is illustrated by increased productivity and therefore increased real wages. In early 19th century England, weekly wages often bought less than a half bushel of good wheat. Toward the end of the century, this had increased to 9 bushels. By 1970 the weekly pay of manufacturing production workers was enough to buy 96 bushels of wheat and by 1977, 110 bushels.[97] Real wages in Great Britain were about three times as high in the late 1970s as in 1890-1899; the indexes (1890-1899=100) for other countries were: France, 442; Germany, 482; Sweden, 473; and the United States, 446.

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[92] Schultz, *Investing in People*, p. 4.

[93] Ibid., p. 7.

[94] Ibid.

[95] Ibid.

[96] Ibid.

[97] Ibid., p. 61.

Most economists not only have calculated returns to education that are large and greater than the return to physical assets, but some believe the calculated rates of return (in terms of money wages) actually understate the true returns to education because these calculations ordinarily exclude fringes and a variety of nonmonetary benefits.[98] Fringe benefits are a particularly important factor, not only because of their growing importance relative to wages, but also because they are significantly larger for high-income groups. Moreover, some fringes are not taxed as current income and therefore have been more attractive to people in higher tax brackets. Furthermore, the returns to education may be understated because schooling probably improves the productivity of other forms of human capital formation such as job training, health maintenance, and household management. It is, in addition, fairly well established that education improves choices in jobs, marriage, migration, crime reduction and citizenship. Bob Haveman and Barbara Wolfe estimate the probable value of these nonmonetary benefits of schooling to be two-thirds of wages.[99]

International Comparisons

International comparisons strengthen our understanding of the individual, fiscal (i.e., government making the investment) and social returns to education. In a 1980 report summarizing estimates from 44 countries, the World Bank reached the following general conclusions:

1. the social and private returns to primary education were higher than for other levels;

2. private returns exceed social returns, especially at the university level;

3. all rates of return to education investments were well above the 10 percent yardstick developing countries use for the opportunity cost of capital; and

4. the highest rates of return were in the developing countries.[100]

Table 6 shows rates of return to higher and secondary education in the United States. During the 1970s there was a slight decline in the private rate of return to higher education, but relative stability in the return to secondary education.

A technical problem involved in these calculations is the assumption that education improves productivity, which, in turn, causes higher wages. This is a problem because wages may or may not reflect productivity--they could be the result of such factors as monopoly or monopsony power, market imperfections, or custom. To avoid this problem, the World Bank commissioned a study of the relationship between education

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[98] Theodore W. Schultz, *The Economic Value of Education* (New York: Columbia University Press, 1963).

[99] Robert Haveman and Barbara Wolfe, "Education, Productivity and Wellbeing," in Edwin Dean (ed.), *Education and Economic Productivity* (Cambridge, MA: Ballinger Publishing Co., 1984), pp. 19-55.

[100] The World Bank, *World Development Report 1980* (New York: Oxford University Press, 1980).

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and physical productivity in agriculture. This study concluded that four years of elementary education improved a farmer's productivity 8.7 percent on the average relative to a farmer with no education.[101] If the complementary relationships of education to factor inputs are included, the productivity of a farmer with four years of education is 13.2 percent higher than for a farmer with no formal education. Complementarity between education and other factors has rather consistently been found to improve performance, whether in such personal outcomes as health and income or productive functions, as in the agriculture example.

Table 6

Returns to Education in the United States
(Percent)

	Education Level	
	Secondary	Higher
Year	Social Rate of Return	
1939	18.2	10.7
1944	14.2	10.6
1959	10.1	11.3
1969	10.7	10.9
	Private Rate of Return	
1970	11.3	8.8
1971	12.5	8.0
1972	11.3	7.8
1973	12.0	5.5
1974	14.8	4.8
1975	12.8	5.3
1976	11.0	5.3

Source: George Psacharopoulos, "Returns on Education: An Updated International Comparison," *Comparative Education*, vol. 17, no. 3, 1981, p. 335.

Other World Bank studies have attempted to overcome some of the earlier technical criticisms of studies suggesting linkages between education and output. One such study of the relationships between literacy, life expectancy and economic growth in 83 developing countries for the period 1960-77 found that the 12 countries with the fastest growth had levels of literacy and life expectancy well above average, which suggests that rapidly growing countries have well developed human resources.[102]

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[101] Dean T. Jamison and Lawrence J. Lau, *Farmer Education and Farmer Efficiency* (Baltimore: Johns Hopkins University Press, 1982), p. 9.

In order to allow for the interactive relationships between economic development, education and other aspects of human resource development, Wheeler developed a simultaneous model which was applied to 88 developing countries. This model suggested that education, nutrition, and health all contribute to the growth of output, directly and indirectly, by lowering birth rates and increasing investment. Wheeler found that increasing the literacy rate from 20 to 30 percent increased gross domestic product by 8 to 16 percent.[103] In a similar study published in 1982, Morris not only found a strong relationship between education and economic growth, but also found that physical capital investments have less effect when not supported by educational investments.[104]

Psacharopoulos and Woodhall conclude, on the basis of the World Bank's extensive experience with investments in education:

> The answer to the question, Is it worth investing in education? is ...resoundingly positive. The question Is it more profitable to invest in human skills and capacities or in physical capital? is misguided, however, since it assumes that investment in people and investment in machines are alternatives. Investment choices should be concerned with *how* rather than whether education can contribute to growth. Their proper concern is which particular combination of general and technical education, which subject balance, which teaching methods, and which distribution of resources and opportunities for schooling would allow education to have the maximum impact on development and would best complement investment in physical capital and infrastructure.[105]

Basic Competencies

As noted earlier, one problem with some studies of returns to education is the fact that they equate schooling with education, or skills. When these adjustments are made, conclusions often are changed. For example, in calculating returns to education it is very important to adjust years of schooling for achievement. This adjustment can be made by looking at scores on achievement tests like the National Assessment of Educational Progress (NAEP) reading, writing, and math tests, the Armed Forces

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[102] Norman Hecks, *Economic Growth and Human Resources*, Staff Working Paper no. 409 (Washington, D.C.: World Bank, 1980).

[103] D. Wheeler, *Human Resource Development and Economic Growth in Developing Countries: A Simultaneous Model*, Staff Working Paper no. 407 (Washington, D.C.: World Bank, 1980).

[104] R. Morris, *Economic Growth in Cross Section*, cited by George Psacharopoulos and Maureen Woodhall, *Education for Development: An Analysis of Investment Choice* (New York: Oxford University Press, for the World Bank, 1985), p. 20.

[105] Psacharopoulos and Woodhall, *Education for Development*, p. 314.

Qualification Test (AFQT), or the SATs and GREs, all of which find large achievement gaps for minorities and low-income people, who usually are concentrated in the bottom 25th percentile. On average, minorities' scores are about 70 percent of those of whites. As can be seen from table 7, the average black 17-year-old is reading at about the same level as the average white 13-year-old.

Relating achievement to competence as is done in table 7 makes it possible to better understand why black high-school graduates have lower earnings and employment levels than white high-school dropouts. This table shows that, regardless of the level of schooling, those with higher skills earn more and that this pattern holds regardless of sex, race, or family income.[106] Berlin and Sum also demonstrate (tables 8 and 9) the close relationship between basic skills and such pathologies as teenage pregnancy, school dropout, and youth unemployment. These analysts note, in addition, the tendency for education achievement of low-income students to deteriorate more during the summer months than is true for high-income groups (figure 8). This summer-loss phenomenon is very important: according to the evidence from studies by Barbara Heynes, 80 percent of the year-to-year differences in educational achievement between advantaged and disadvantaged students is due to summer loss.

One pilot project, the Summer Training and Education Project (STEP), has demonstrated that the summer loss in math can be completely overcome and the reading loss greatly reduced. STEP is a five-site demonstration project operated jointly by school officials and employment and training staff employed with the federal summer jobs program. STEP provides 14- and 15-year-olds who are behind in school with a half day of work experience (more than 80 hours during the summer) and a half day of intensive remedial education, as well as 18 hours of "life planning instruction." At the end of STEP's first summer, youth who had work experience only (the control group) lost between three-fourths and a full grade equivalent in reading and a half grade in mathematics. STEP participants, by contrast, lost only 0.3 of a grade in reading and actually gained 0.2 of a grade in math. Black and Hispanic students did especially well.[107]

Environmental and Pre-School Influences

Considerable evidence indicates that learning is influenced by certain broad historical and demographic trends, especially as they influence the family and early childhood development. These trends, which cause many disadvantaged children to start school behind their more advantaged peers, have had a profound impact on the family as a learning system. Also, events that occur from birth or even before have repercussions for learning and development for children for the rest of their lives. It is therefore necessary to understand these matters if we want to develop a world-class education system.

In preindustrial times, when the family was the basic economic unit, children learned by close observation of their parents, siblings, and extended family members. Industrialization and the increased reliance on labor markets caused families to become

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[106] Gordon Berlin and Andrew Sum, "American Standards of Living."

[107] Berlin and Sum, 1988, *Toward a More Perfect Union*, pp. 45-46.

Table 7

The Achievement Gap: The Central Issue in Educational Reform

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

Mean Reading Proficiency Scores of 9, 13 and 17 Year-Olds, by Race,
Type of Community and Parental Education: 1971-1984

	9 Year-Olds			13 Year-Olds			17 Year-Olds		
	1971	1984	Change 1971-1984	1971	1984	Change 1971-1984	1971	1984	Change 1971-1984
Race									
White	214.4	220.1	+5.70	260.1	263.4	+3.30	290.4	294.6	+4.20
Black	169.3	188.4	+19.10	220.3	236.8	+16.50	240.6	263.5	+22.90
Hispanic	182.9*	193.0	+10.10	231.1*	239.2	+8.10	254.7*	268.7	+14.00
*Achievement Gap White-Black	45.10	31.70	-13.40	39.80	26.60	-13.20	49.80	31.10	-18.70
Type of Community									
Advantaged Urban	231.3	231.4	+.1	272.4	274.7	+2.30	303.5	300.8	-2.70
Disadvantaged Urban	177.8	194.4	+16.60	232.4	239.6	+7.20	259.4	265.9	+6.50
Rural	200.7	205.8	+5.10	245.0	255.5	+10.50	275.8	282.8	+6.40
*Achievement Gap Adv. Urban-Disadv. Urban	53.50	37.00	-16.50	40.00	35.10	-4.90	44.10	34.90	-9.20
Achievement Gap Adv. Urban minus Rural	30.60	25.60	-5.00	27.40	19.20	-8.20	27.70	18.00	-9.70
Parental Education									
Graduated HS	209.0	211.4	+2.40	255.4	253.8	-1.60	282.9	280.6	-2.30
Non-Graduate	188.6	197.1	+8.50	236.2	241.5	+5.30	263.4	269.5	+6.10
Post HS	224.7	224.3	-.40	269.7	268.4	-1.30	300.9	300.0	-.90
*Achievement Gap HS Grads vs. Non-Grads	20.40	14.30	-6.10	19.20	12.30	-6.90	19.50	11.10	-8.40

*Data for 1974--not available for 1971.

Source: Gordon Berlin and Andrew Sum, "American Standards of Living, Family Welfare and the Basic Skills Crisis," speech delivered at conference on School Employment and Training Officials sponsored by the National Governors Association and the Chief State School Officers, December, 1986.

Table 8

Average Annual Earnings, 1979-1981

Out-of-School Youth, Ages 19-23 with 12 or Fewer Years of Schooling in 1981 by Test Score Rank on the Armed Forces Qualification Test

	Males		Females	
Skills Level	Dropouts	Graduates	Dropouts	Graduates
Lowest Quintile	$4,616	$ 6,013	$1,429	$2,936
Second Lowest Quintile	6,595	8,639	2,156	4,235
Middle Quintile	6,765	8,188	3,102	4,629
Second Highest Quintile	8,321	9,433	2,798	5,469
Highest Quintile	9,086	10,740	4,479	6,003

Source: National Longitudinal Survey of Young Americans, 1979-81 public use tapes; tabulation by the Center for Labor Market Studies, Northeastern University, for Gordon Berlin and Andrew Sum, *Toward a More Perfect Union*, New York: The Ford Foundation, 1988, p. 11.

Table 9

AFQT Test Score Position of 19-23-Year-Olds by Poverty and Social/Economic Group, United States, 1981

Socioeconomic Characteristics	Percent in Lowest Fifth of Basic Skills	Percent Below-Average Basic Skills
Poor	46	77
One or more social/economic problems	41	75
Jobless	40	72
Dropout	52	85
Public assistance recipient	53	79
Unwed parent	59	85
Arrested past year	37	68

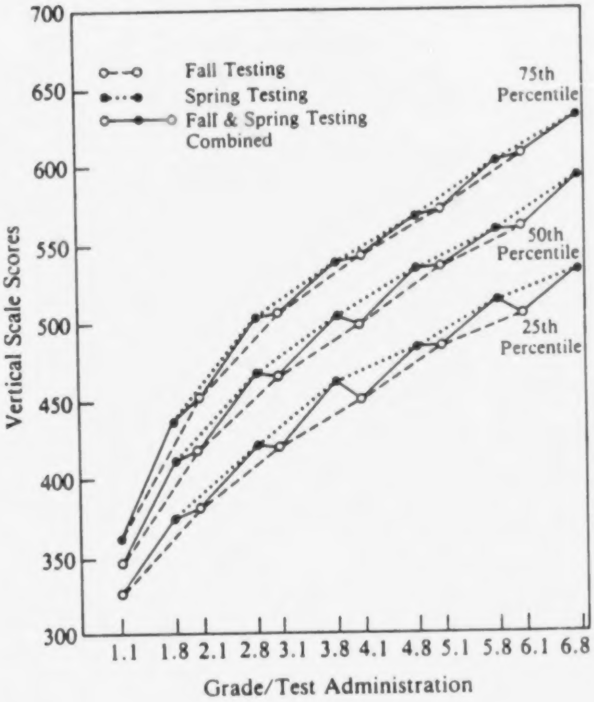
Mean Percentile Ranking in Basic Skills Distribution

All 19- to 23-year-olds	50
Arrested	32
Jobless	26
Dependent	24
Poor	23
Two Social Problems	22
Poor plus one social problem	21
Unwed parent	21
Dropout	20
Poor and idle	18
Poor and dependent	16
Three or more social problems	15

Source: Gordon Berlin and Andrew Sum, *Toward a More Perfect Union*, New York: Carnegie Corporation, 1988, p. 29.

Figure 8

Summer Loss in Learning



Source: Gordon Berlin and Andrew Sum, *Toward a More Perfect Union*, New York: The Ford Foundation, 1988, p. 37.

Note: The intervals 1.8 to 2.1, 2.8 to 3.1, and so forth correspond to the summer break from school. The zigzag lines show the summer loss that occurs among youth with test scores falling in the 25th, 50th, and 75th percentiles. Note that the largest loss occurs among those children who score in the lowest percentile, those who are already the farthest behind academically.

Vertical scale scores are shown as a function of grade level by quartiles for the debiased CTBS reading test.

much less significant as producing and learning units; it thus became less possible for children to understand their parents' work by personal interaction and observation, as they had done throughout human history. With the changes accompanying industrialization, moreover, the period of adolescence has become longer and more complicated than ever before. There are no clear-cut tests for passage from adolescence into adulthood. In addition, the images that young people have of the world beyond their homes is mainly through electronic media--especially television, which apparently has had a powerful influence. As a consequence, television as a learning institution probably has become as important as schools, parents, or peers. Television has certainly captured the attention of young people in a way most schools never have. A challenge for the formal education system is to find ways to use television and other technology to achieve education objectives. Programs like Sesame Street have accomplished this goal for preschool children, but no similar approach has been used to reach elementary and secondary school students. There are, however, some experiments underway, like "De Grassi Junior High," a half-hour drama series aired by PBS in the Fall of 1987. The main objective of this series is to attract the attention of young people (mainly 7th and 8th graders), convey some information, and provide ideas for discussion. This program has been shown in Canada, apparently with very positive effects. "De Grassi Junior High" seeks to integrate learning through a format that attracts young people's attention and strikes them as true-to-life. The show attempts to teach decisionmaking by depicting, in dramatic situations, the kinds of choices and problems young people are likely to encounter at various stages in their development.

Beyond these special programs, educators are giving some thought to using the programs young people are watching on television as learning devices. Most experts seem to agree that television can affect behavior in positive or negative directions, which, of course, is what advertising and political campaigns are all about. They also agree, however, that to be most effective there must be collaboration between what is seen on television and other learning processes (i.e., peers, family, school). Television is mainly concerned with entertainment, not enlightenment. The challenge is to bring these relationships closer together by using television as part of the learning process for teachers and students.

Those concerned with education must also understand broad societal changes as they affect the family. The increased labor-force participation of women, the rising incidence of single-parent families, and the "feminization of poverty" are particularly important for the education process. These changes have important implications for the development of children. Of special concern are the children in high-poverty concentration areas. As noted, these children are likely to constitute a disproportionate share of the future growth of the American (and Texas) populations and work forces.

The children in high-risk situations often enter formal schools with serious physical, social, and psychological problems. These children and their parents, especially their mothers, are vulnerable to a multiplicity of threats early in life that affect their health and learning abilities later on; these include low birth weights, neonatal damage, malnutrition, untreated diseases, and uncorrected physical impairments. High risk children are, in addition, subject to high levels of stress on a long-term and continuing basis. Their mothers often are very young and very poor. These children consequently have few positive role models or sources of social stability. As David Hamburg emphasized:

> From the time they enter school [these high risk children] are often observed to be underdeveloped in their social skills, emotionally troubled, linguistically and cognitively well behind their peers who come from more fortunate circumstances. By the third grade many of them are found to be unsuitable for the science education that could equip them for even moderately technical occupations later in life.[108]

Reviewing a vast amount of research, much of it funded by the Carnegie Corporation of New York, of which he is president, Hamburg concludes:

1. Children who have suffered serious intellectual damage because of their environment can improve their intelligence and learning abilities by being placed in more stimulative environments. This achievement also has been demonstrated by comparing siblings who remain in impoverished circumstances with their brothers and sisters who were placed in more enriched circumstances.

2. Prenatal care is essential for ensuring the healthy development of children. Much irreversible damage can be done to children in the first eight weeks after conception when most organ development--including the central nervous system--takes place. Because the lack of adequate nutrition and health care has such profound ramifications, the federal supplemental food program for women, infants and children (WIC) has been one of the nation's most cost-effective programs--for every $1 invested in the program, according to a study by the Harvard School of Public Health, $3 is later saved in medical costs.

3. After birth, child development is strongly affected by parent behavior. Health development depends heavily on whether or not the child has a loving, happy, teaching, coping parent during the first and second years of life; "Recent research. . .has shown that insecure attachment in infancy is predictive of later behavior problems in early and middle childhood."[109] Moreover, there are a variety of reliable predictors of the links between "the security of infant-parent attachments and later social competence, emotional distress, functioning in school and prosocial behavior."[110]

4. Despite the damage that can be done to children early in life, "there is abundant evidence that children with poor early relationships can recover later if the environment improves."[111]

5. There is much basic research to show that:

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[108] David Hamburg, "Early Intervention to Prevent Lifelong Damage: Lessons from Current Research," testimony for the Senate Committee on Labor and Human Resources and the House Committee on Education and Labor, September 9, 1987, pp. 1-2.

[109] Ibid., p. 11.

[110] Ibid., p. 12.

[111] Ibid., p. 10.

> Quality programs in the 4-5 year age range have strong potential for diminishing a variety of later academic health and social problems. Over 20 years the convergence of evidence from a variety of longitudinal studies, including Head Start evaluations, is highly significant. Benefits to society. . .are improved educational achievement, reduced crime and delinquency, improved productivity of the labor force, reduced welfare dependency, and better health status of the population.[112]

Hamburg, a physician, psychiatrist, and former president of the National Academy of Science's Institute of Medicine, concludes:

> . . .the most crucially formative periods of development in the entire life span are the first few years of life and early adolescence. . .there are several recurrent features of the research literature that are related to the effectiveness of intervention for young parents and their very young children. . .

The most successful interventions in the 0-5 age period have certain basic characteristics:

1. They start early.
2. They involve parents substantially in the effort for the long pull.
3. They strengthen natural support networks.
4. They provide educational activities for young children that have a moderately stimulating quality.
5. They sustain contact with mothers and children over relatively long periods.

Overall, there appear to be potentially strong effects of combined (1) parent education, (2) quality day care, (3) fostering of social support networks.[113]

There is, in addition, strong evidence that early interventions, especially to improve the education of mothers, can do much to break the generational cycles of poverty. In fact, parents' education turns out to be a powerful predictor of the educational attainment of their children. Moreover, education is a powerful determinant of whether or not young mothers escape poverty. According to longitudinal research by Frank Furstenberg and others that followed 300 city teenage, mostly minority, mothers for 17 years:

> Contrary to expectations, teenage childbearing did not lead inexorably to a lifetime of poverty and dependence for all women. More than half eventually escaped poverty altogether. Education was the most potent avenue for escape from poverty and welfare, even when a

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[112] Ibid., pp. 18-19.

[113] Ibid., pp. 48-49.

> mother waited until her twenties or thirties to go back to school. Mothers who returned to school were more likely to marry and more likely to work. This change in the mother's own life generally resulted in measurable improvements in the achievement of her children.[114]

In conclusion, while it is not decisive enough to convince everyone, a preponderance of evidence supports the conclusion that human capital (which includes health and child care as well as education) and advances in knowledge are powerful forces to improve productivity and national and personal incomes. Moreover, basic education is positively associated with overcoming many important social pathologies. The question remains, however, whether these basic competencies are acquired in schools and if so, what can be done to make schools more productive. We have seen that not all learning is in the schools--much takes place in the home, especially before a child is five years old, and with peers, the media, and other community institutions. Much learning also takes place on the job. Indeed, many critics have argued that the schools have much less influence on learning than these other institutions.

OTHER LEARNING SYSTEMS

An understanding of learning systems requires that we relate formal schooling and *informal learning systems*. One of the most important of these is the family. Indeed, in the United States and other developed countries, family income is one of the strongest predictors of *average* educational achievement. The importance of the family as a learning system is one of the reasons that improving mothers' health, education, and nutrition can do much to break the generational aspects of poverty and low incomes. Indeed, since the mother's health at the time of conception and during pregnancy could influence the child's learning ability, interventions like the federal women's infants and children (WIC) program, which provide health and educational services to low-income women and children, yield high personal, fiscal and social returns. There is strong international evidence that low birth weight is associated with a variety of learning disorders and that high quality preschool programs could significantly reduce dropouts, crime, welfare dependency and lagging school performance.[115] The Committee for Economic Development (CED), a policy-oriented business organization, found that the prenatal component of the WIC program returned $3 for every $1 spent; a quality preschool program returns $4.75 for each dollar spent "because of lower costs of special education, public assistance, and crime." Despite these returns, the WIC and Head Start programs serve only about one-third and one-fifth respectively of potential eligibles.[116]

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[114] The research is by Frank F. Furstenberg, J. Brooks-Gunn and S. Philip Morgan, *Adolescent Mothers in Later Life* (Cambridge: Cambridge University Press, 1987); the quotation is from Berlin and Sum, *Toward a More Perfect Union*, p. 39.

[115] James S. Cotterell, *On the Social Costs of Dropping Out of School* (Stanford University: Education Policy Institute, December 1985), p. 17.

[116] Committee for Economic Development, Research and Policy Committee, *Children in Need* (Washington, D.C.: CED, 1987), pp. 6-7.

In developing its education policies we also should consider the relationships between schools and "second chance" systems for people who either do not make it through high school or do not go on to college. Non-college-bound young people constitute a very large group of about 20 million people, or about half of all 16-24 year olds. In fact, the school-to-work process is one of the weakest links in the American labor market system (or "non system") relative to all other industrialized countries. A few young people go into apprenticeship or technical training programs that lead to the skilled trades. And a larger number enter on-the-job or corporate learning programs. The most serious problems are with high-school dropouts and those with limited labor market connections who do not make it into learning systems that lead to better opportunities. This state of affairs is particularly unfortunate because, as noted earlier, the earnings of young males who do not get postsecondary schooling are declining absolutely and relative to those who do. There are particularly serious problems for young, non-college-bound blacks.

The problems for many non-college-bound young people are all the more unfortunate in view of the evidence that "second chance" education and training programs yield high returns to the government and to the young people who participate in them. For example, the CED reported that the Job Corps returned $7,400 per participant for each $5,000 invested (in 1977 dollars). Unfortunately, despite great need, by 1987 funding for federal employment and training programs had been reduced to about one-third of their 1978 level in real terms.

The learning opportunities for these non-college-bound young people raise important equity issues. College students benefit greatly from the $112 billion postsecondary school system (about $10,000 per enrollee) and after they graduate they are the principal beneficiaries of the $210 billion American companies spend on education and training. By contrast, the federal government spends only $636 million on training and employment services for youths 21 and younger under the Job Training Partnership Act (JTPA) and only $656 million on the highly successful Job Corps.

Equity and economic efficiency considerations therefore require at least a doubling of these "second chance" funds for non-college-bound young people. JTPA, passed in 1982, also should provide more funds for supportive services for trainees and for public service jobs for those who are not likely to find private sector employment. The JTPA should, in addition, change its performance standards to emphasize services to the most seriously disadvantaged; the present main success criteria--cost reductions and placements--encourage program sponsors to "cream" and therefore do the least for those who need the most help.[117]

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[117] For excellent discussions see William T. Grant Foundation Commission on Work, Family and Citizenship, *The Forgotten Half: Non-College Youth in America*, an interim report on the School-to-Work Transition (Washington, D.C.: William T. Grant Foundation, January 1988; and Sar Levitan and Frank Gallo, *A Second Chance: Training for Jobs* (Kalamazoo, Mich.: The Upjohn Institute for Employment Research, 1988).

PUBLIC SCHOOL EFFICIENCY

Many studies have attempted to determine the factors responsible for efficiency in public schools.[118] Although the scope and methods differ in these studies, they generally find substantial differences in the quality of schools, but:

> differences in quality do not seem to reflect variations in expenditures, class sizes, or other commonly measured attributes of schools and teachers. Instead they appear to result from differences in teacher "skills" that defy detailed description, but that possibly can be measured directly.[119]

However, efforts to measure differences in school quality have so far not been very successful. Measurements of other outcomes have been more successful. Two commonly used measures of elementary and secondary school performance are retention and school completion rates (table 10). These numbers have increased significantly since 1950.

Table 10

School Retention and School Completion Rates

	1950	1980
School Retention		
% graduating from high school	50.5	74.4
% entering college	20.5	46.3
School Completion		
Median years completed	12.0	12.9
% 4 years high school or more	52.8	84.5

Source: U.S. Department of Commerce, *Statistical Abstract of the U.S.*, 1985.

Another way to gauge performance is in terms of scores on the Scholastic Aptitude Test (SAT).[120] The steady decline in SAT verbal and quantitative scores beginning in 1963 has been a cause of considerable comment. The verbal scores fell about 0.5 standard deviation between 1963 and 1979, but increased by less than 0.1 of a standard deviation between 1979 and 1984; the magnitudes were not as large, but the math scores followed the same pattern. Between 1980 and 1987, SAT scores regained only 16 of the 90 points they lost between 1963 and 1980. While scores for white students declined slightly, minority students gained between 1976 and 1987: black students' composite scores increased from 686 to 728, Hispanics from 781 to 803, while white scores declined from 944 to 936. Thus, while wide gaps occur between the scores of minorities and nonminorities, these differences have been narrowing in recent years.[121]

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[118] For a good summary see Eric A Hanushek, "The Economics of Schooling: Production and Efficiency in Public Schools, *Journal of Economic Literature*, September 1986, pp. 1141-1177.

[119] Ibid, p. 1142.

[120] For a review see Congressional Budget Office, *Educational Achievement: Explanations and Implications of Recent Trends* (Washington, D.C.: Congressional Budget Office, 1986).

Other recent changes in public school indicators include:

1. Real expenditure per average daily attendance (ADA) more than doubled between 1950 and 1983, from $1,598 in 1950 to $3,261 in 1983.

2. Pupil-teacher ratios declined as follows:

	1960	1980
Public schools (total)	25.8	19.0
elementary	28.4	20.5
secondary	21.7	17.1
Private schools (total)	30.7	17.9
elementary	36.1	19.3
secondary	18.6	15.0

3. Average teachers' salaries rose dramatically during the 1960s, but (like the wages of all workers) fell in real terms in the 1970s, despite the aging (and therefore greater experience) of teachers. In real terms, teachers' salaries were $17,406 in 1960, $23,296 in 1971, and $21,790 in 1983. The American Federation of Teachers reported the average teacher's salary was $28,085 in 1987-88.[122] As a result of widespread concern about teacher shortages and school reform, teachers' salaries have increased sharply since 1983, while real wages generally have been stagnant. On the basis of these statistics, critics argue that the schools have deteriorated despite (some would say because of) increased teachers' salaries and expenditures per ADA. If, they argue, schools were efficient or had much to do with education, how could we have declining SAT scores on the one hand and increasing per-pupil expenditures, declining class sizes, and rising teachers' salaries on the other?

Economists have tried to answer this question by explaining the factors responsible for school performance through use of production functions (or benefit-cost or cost-quality) studies that relate output (SAT or other scores) or dependent variables to a series of independent (or causal) variables; these ordinarily are such matters as expenditure per ADA or the characteristics of teachers (i.e., education, salaries, experience, or skills).

Most of these studies fail to show clear and unambiguous relationships between inputs and student performance:

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[121] William J. Bennett, *American Education: Making it Work* (Washington, D.C.: U.S. Department of Education, April 1988), pp. 9-10.

[122] American Federation of Teachers, unpublished data.

1. An early production function study was the very controversial 1966 *Coleman Report on Equality of Educational Opportunity*, mandated by the Civil Rights Act of 1964. This report appeared to show that family backgrounds and characteristics of students and not differences in schools accounted for most of the differences in student performance.[123]

2. Some critics argue that schooling does not improve the skills and earnings of students, but merely acts as a screening device to select the most able.[124] Screening rather than skill improvement implies that the social returns to schooling are smaller than the individual returns.

3. Jencks et al., argue that earnings differentials are more the result of luck and personal characteristics than improved skills.[125]

4. Bowles and Gintis argue, in the radical tradition, that differences in earnings are caused mainly by capitalist social structure rather than the skill differentials produced by schooling. They also argue that schools adapt to the capitalist social structure rather than being an independent force.[126]

5. Hanushek, summarizing well over a hundred such studies, concludes:

   A. "of the 112 estimates of the effects of class size [on student performance], only 23 are statistically significant, and only 9 show a statistically significant relationship of the expected positive sign. Fourteen display a statistically significant negative relationship." An additional 89 were not significant at the 5 percent level; "the insignificant coefficients have the 'wrong sign' by a 43 to 25 margin."[127]

   B. Similarly, most of the 106 studies of the influence of teacher education show no relationship to student performance.

   C. Teacher experience is one weak, but possible, exception: "a clear majority of estimated coefficients [point] in the right direction, and almost 30 percent are statistically significant. . ."

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[123] James S. Coleman et al., *Equality of Educational Opportunity* (Washington, D.C.: U.S. Government Printing Office, 1966).

[124] Ivar Berg, *Education and Jobs: The Great Training Robbery* (N.Y.: Praeger, 1970); Andrew Weiss, "A Sorting-Cum Learning Model of Education," *Journal of Political Economy*, June 1983, pp. 420-442.

[125] Christopher Jencks et al., *Inequality: A Reassessment of the Effects of Family and Schooling in America* (New York: Basic Books, 1972), p. 254.

[126] Samuel Bowles and Herbert Gintis, *Schooling in Capitalist America* (New York: Basic Books, 1976).

[127] Hanushek, "The Economics of Schooling," p. 1161.

D. Sixty studies of teachers' salaries and 65 of expenditures per student "provide no separate indication of a relationship between expenditures and achievements. Most data do show a strong positive simple correlation between school expenditures and achievement, but the strength of this relationship disappears when differences in family background are controlled for." Moreover, studies of the effects of peers on student performance produce ambiguous results.[128]

E. The factors most strongly correlated with student performance are:

   (1) family background: "Virtually regardless of how measured, more educated and more wealthy parents have children who perform better on average."[129]

   (2) There are marked quality differences in schools and teachers. Teachers who perform better on verbal ability tests have better classroom performance, though the relationship is not strong.[130]

   (3) The skills of teachers as assessed by their supervisors have been found to be highly correlated with their students' adjusted achievement gains.[131]

Effective Schools Research

One of the main criticisms of early work on the relationship between schooling and incomes was the fact that studies like Coleman's were based on input-output techniques that failed to capture the impact of the kinds of processes within schools that might actually have been responsible for improved student achievement. Coleman concluded in his 1966 study that "differences between schools account for only a small fraction of differences in pupil achievement" and that "the school appears unable to exert independent influences to make achievement levels less dependent on the child's background--and this is true within each ethnic group, just as it is between groups."[132] Similarly, Jencks concluded in 1972 that equalizing the quality of elementary or high schools would have only a marginal effect on decreasing cognitive inequality.[133] The main criticism of the Coleman and Jencks input-output studies was their failure to account for the processes by which resources were used in the schools to achieve desired outcomes.

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[128] Ibid., p. 1162.

[129] Ibid., p. 1163.

[130] Eric Hanushek, "Throwing Money at Schools," *Journal of Policy Analysis Management*, Fall 1981, pp. 19-41.

[131] Richard J. Murnane, *Impact of School Resources on the Learning of Inner City Children* (Cambridge, MA: Ballinger, 1975); David Armor et al., *Analysis of the School Preferred Reading Program in Selected Los Angeles Schools* (Santa Monica, CA: The Rand Corporation, 1976).

[132] Coleman, *Equality of Educational Opportunity*, pp. 21, 297.

[133] Jencks, *Inequality*, pp. 96, 109.

Subsequent studies sought to overcome these defects. Studies that analyzed the allocation of school resources to particular students found positive relationships.[134] Moreover, studies found more positive relationships when they looked at the effects of specific schools rather than the average effect of all schools. And within these effective schools, a consensus emerged that student achievement could be improved if schools were able to achieve certain characteristics like strong leadership, positive expectations about their students' learning abilities, emphasis on basic skills, allocation of school resources to basic skills goals, an orderly atmosphere, frequent monitoring of performance, and constant feedback to students about their performance.[135]

These "effective schools" studies have been criticized on a number of grounds, including: examining too few schools, inconsistent and sometimes contradictory findings, limited focus, and low standards of effectiveness. A major criticism of the effective schools studies was their failure to demonstrate how the factors associated with effective schools actually increased learning. Moreover, since family backgrounds have usually been found to be strongly associated with achievement, the failure of these studies to adequately control for, or measure the effects of, these background factors on learning weakened their acceptability. We should also note that, even when the "effective schools" improved the conditions of disadvantaged students, the standards for success were often far below the national average or the levels in schools attended by high-income students.[136]

Despite these shortcomings, critics acknowledge that the effective schools research has extended the debate and had a more positive effect on public opinion than the pessimism implied by the Coleman and Jencks studies. Moreover, despite methodological shortcomings, critiques usually conclude that the effective schools conclusions are essentially valid. Purkey and Smith, for example, found:

> a substantive case emerging from the literature. There is a good deal of common sense to the notion that a school is more likely to have relatively high reading or math scores if the staffs agree to emphasize those subjects, are serious and purposeful about the task of teaching, expect students to learn, and create a safe and comfortable

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[134] See Anita A. Summers and Barbara L. Wolfe, "Do Schools Make a Difference?" *American Economic Review*, September 1977, pp. 639-652.

[135] Michael Cohen, "Effective Schools: Accumulating Research Findings," *American Education*, January-February 1982, pp. 13-16; Lawrence C. Stedman, "A New Look at Effective Schools Literature," *Urban Education*, October 1985, pp. 295-326.

[136] Brian Rowan, Steven T. Bossert, and David C. Dwyer, "Research on Effective Schools: A Cautionary Note," *Educational Researcher*, April 1983, pp. 24-31; William A. Firestone and Robert E. Herriott, "Prescriptions for Effective Schools Don't Fit Secondary Schools," *Educational Leadership*, December 1982, pp. 51-53; Stewart C. Purkey and Marshall S. Smith, "Too Soon to Cheer? Synthesis of Research on Effective Schools," *Educational Leadership*, December 1982, pp. 64-69.

> environment in which students accurately perceive the school's expectations for academic success and come to share them.[137]

One of the most important conclusions from the effective schools research is that schools do in fact differ in their effectiveness and that the differences are important. Moreover, research by economists using production function techniques has demonstrated positive relationships between resources per pupil, achievement scores, and earnings. However, a puzzling outcome of these studies is that while total expenditures per pupil seem to be associated with positive effects, particular expenditures for such things as library books, science labs, and the size and age of schools "in general are not statistically powerful determinants of school effectiveness."[138] On the other hand, the character of the human resources used in the schools seems to matter a great deal. These include the teachers' intellectual skills as measured by verbal ability tests, the quality of the college attended by the teacher, and the teachers' experience. Most studies show some teachers to be systematically more effective than others.

A major problem with many of the economic studies of education is the fact that they are based on assumptions from standard production function theory, which assumes that a school is like a factory with certain inputs and outputs (achievement, wages, human capital). The standard production function assumptions are (1) decisionmakers are rational, so that they operate on their production functions (i.e., they choose inputs and techniques rationally from a set of well-defined and well-known possibilities) and (2) the relationships between inputs and outputs (i.e., technologies) are fairly well established and generally available. As noted in our discussion of management systems, these standard assumptions of traditional economic theory are highly questionable even when applied to a manufacturing firm. A major defect of both scientific management and production function theory is their assumption that there is one best way to do a thing. In fact, of course, there is no one best technology for every work situation. Indeed, the objective of management or production systems is to discover the technology and productive function that is most suited to them. As Murnane and Nelson emphasize, many techniques used in production are tacit and idiosyncratic; *tacit* means a capability that is felt or intuited rather than being well articulated and *idiosyncratic* means there is no one best way to do a particular thing. Murnane and Nelson's basic theme is that "the conventional economic theory of production, based as it is on an implicit assumption that techniques can be largely described, explained, and learned through scrutiny of blueprints does not hold, even approximately, in a field like education."[139]

These analysts suggest an alternative that explains the puzzle of why aggregate expenditures per pupil have positive associations with outcomes--and why the quality of both teachers and fellow students make a difference--while the inputs of particular physical resources do not seem to make much difference, or why certain techniques work in some settings and not others.

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[137] Purkey and Smith, "Too Soon to Cheer?" p. 67.

[138] Richard J. Murnane and Richard R. Nelson, "Production and Innovation when Techniques are Tacit: The Case of Education," *Journal of Economic Behavior and Organization* 5, 1984, p. 357.

[139] Ibid., p. 356.

> . . .[T]he variation in educational practice is unavoidable and in fact is crucial to effective teaching. The reason is that effective teaching requires information about the skills and personalities of students and about how students interact that can only be obtained during the classroom teaching process. Also, teachers vary greatly in the kinds of interactions they are good at. In other words, effective teaching requires intensive problem solving activity, and creative and personalized responses to frequent unpredicted circumstances. It is clear that this interpretation. . .casts a shadow on the faith that what one teacher or school is doing with success, another can replicate with comparable effect.[140]

The other main implication of this thesis, which, on the basis of my research and experience in non-school production systems, I believe to be correct, is that the different outcomes from the different effective schools studies are not due to technical failures in the studies.[141] In other words, the best approach to educational reform is to get good teachers and students and create learning situations in which the best techniques can be discovered in each setting. There is no one "best" set that can be discovered through quantitative analysis that would fit all situations. A good teacher helps learners discover what works for them, understands what is worth learning, and provides incentives for students to learn. As noted, moreover, the general requirements found by the effective schools research are useful guides.

Corporate Classrooms

Further evidence with respect to the impact of education on earnings and employment is provided by an analysis of the effect of education on kinds of jobs and on-the-job (OJT) learning opportunities school leavers are able to get. This consideration is very important because on-the-job education and training yield high returns for those able to get into the best learning opportunities. Although precise information is not available on corporate education programs, what is known suggests that these institutions invest at least as much on education as all American colleges and universities and have at least as many students.[142] Over 100 corporations provide in-house courses for their employees that can lead to academic degrees. Indeed, about 18 corporate institutions award degrees themselves, and it is expected that this number will grow.

The following data from the American Society for Training and Development (ASTD) provide the most comprehensive information on the *size* of the learning enterprise in the U.S. in the middle of the 1980s (table 11).

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[140] Ibid., p. 362.

[141] See Ray Marshall, *Unheard Voices*.

[142] See Eurich, *Corporate Classrooms*.

Table 11

Learning Enterprises in the U.S.

		Expenditures (billions)
1.	Elementary and secondary schools	$144
2.	Post secondary	94
3.	Employee informal training	180
4.	Employee formal training	30
5.	Government training	5
		$453

Source: Anthony Patrick Carnevale, "The Learning Enterprise," *Training and Development Journal*, January 1986, p. 18.

These data suggest that expenditures for training and education by the private sector are over twice as large as all post secondary training in the United States. Moreover, ASTD's studies suggest that corporate learning systems, not regular schooling, mainly determine what people will earn over their working lives.

The importance of different learning systems varies with the nature of the occupations. Informal OJT is most important for machine operators, the crafts, and farming, forestry, and fishing workers, all of whom get most of their training this way. Formal company programs are nevertheless relatively important for craft workers, the occupational group receiving the highest proportion of formal company training (26%); followed by service workers (25%); machine operators and laborers (18%); managerial, professional, and technical workers (15%); and farming, forestry and fishing (5%). Schooling outside of companies was most important for managerial, professional, and technical workers (60%); followed by service workers (36%); farming, forestry, and fishing industry workers (30%); craft workers (24%); and machine operators and laborers (13%).

Per employee training expenditures, by industry, according to the ASTD study, are listed in table 12.

Table 12

Per Employee Training Expenditures, by Industry

Industry	Expenditures (dollars)
Public administration	645
Mining	566
Finance, insurance and real estate	529
Durable goods	314
Services	283
Nondurable goods	260
Manufacturing	258
Trade	136
Construction	127
Agricultural products and services	54

Source: Anthony Carnevale, "The Learning Enterprise," *Training and Development Journal*, January 1986, p. 20.

Most formal workplace training is provided to employees in the 25-to-44-year-old age group and to managers, professionals, and clericals. Training for blue-collar workers was more likely to be informal and on the job, although, as noted, craft workers are the group receiving the highest proportion of formal company training. Most employer-sponsored training takes place in-house, although more than a third is done outside, mainly by schools.

The ASTD study, like others, indicates high returns to training. An analysis of 1983 census data found real productivity returns to corporate learning systems to be 12.6 percent for college educated workers and 19 percent for non-college-educated. Not surprisingly, the best jobs in terms of lifetime earnings are those with the best OJT learning opportunities. "Econometric studies have consistently shown that 15 percent in the variation of income among Americans can be accounted for by formal education. The remaining 85 percent is accounted for by learning in the workplace. Earnings are driven by the ability of working teams to learn together in the context of appropriate technology."[143]

A variety of motives are behind these corporate learning programs. A major factor is the belief that outside educational institutions cannot provide adequate learning opportunities as flexibly or as efficiently as the companies can do it themselves. A major motive by high-tech companies is to provide remedial work, especially in mathematics, science, and technical subjects, in order to overcome the public schools' deficiencies in these subjects. Some companies believe, in addition, that education is not only a way to improve their employees' knowledge and skill, but also makes it possible to recruit and retain the most talented workers. Clearly, moreover, intensified competition has provided a major impetus for corporate education programs. Most high-tech companies are particularly concerned about the quality of their work forces relative to their foreign competitors. For example, Edward W. Bales, the director of the Training and Education Center (M-TEC) of Motorola, Inc., believes Motorola has to supplement the education of entry-level employees who "have nowhere near the mathematical competence of our Japanese competition." Bales cited a study funded by the International Association for the Evaluation of Education Achievement that found, among other things, that elementary school pupils in Japan had the same math achievement level as junior high school students in the U.S. "It has become a big issue," Bales said, "because we don't think we can gain the competitive edge unless our workers are better educated."[144] Corporations like Bell South established their own accredited education programs because regular colleges did not have the expertise or the equipment to teach telecommunication courses. Many of these corporate schools have been opened to the public and therefore compete directly with regular colleges, universities, and technical institutions. The efficiency of these corporate learning systems will undoubtedly force colleges and universities to reexamine their teaching methods. The corporate need to provide remedial education also has caused many business leaders to become heavily involved in the education reform movement. As they have done so, they have been surprised to discover the wide gap between their poor assessment of the public schools and the extent to which school officials thought they were doing a good job.

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[143] Carnevale, *Human Capital*, p. 24.

Corporate dissatisfaction with the schools is not restricted to poor rural areas of the South. In 1987 only 16 percent of the 21,000 applicants for 780 slots passed the New York Telephone Company's basic reading and reasoning skills test. Many companies perceive a deterioration in the quality of applicants at the very time their education and skill requirements are increasing. High-tech companies, especially, have concluded that improvements in education are crucial to improvements in productivity. David Kearns, chairman of Xerox, believes "Education is a bigger factor in productivity growth than increased capital, economies of scale, or better allocation of resources."[145]

Not only are corporations experimenting with better education methods, but many of them have funded basic research projects to improve their understanding of the learning process itself.

A 1986 study for the U.S. Department of Labor by the Rand Corporation deepens our understanding of the relationships between corporate and public learning systems as well as of the nature and outcomes of company systems.[146] The Rand study used three major data sets: (1) the national Current Population Survey (CPS); (2) the National Longitudinal Survey (NLS), which has cohorts of young men, women, and mature men; and (3) the Employment Opportunity Pilot Projects (EOPP) survey, taken mainly between May and September 1980. Since EOPP was the Carter administration's welfare reform demonstration project, it included nonpoor households but oversampled the poor; it is therefore a good source of information on the economically disadvantaged.

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[144] Constance Mitchell, "Corporate Classes: Firms Broaden Scope of their Education Programs," *Wall Street Journal*, September 28, 1987, p. 35.

[145] Janice C. Simpson, "A Shallow Labor Pool Spurs Business to Act to Bolster Education," *Wall Street Journal*, September 28, 1987, p. 1.

[146] Lee A. Lillard and Hong W. Ton, *Private Sector Training: Who Gets it and What are its Effects?* (Santa Monica, CA: The Rand Corporation, March 1986).

The Rand study confirmed some basic assumptions about the effects of education on earnings and employment:

1. Postschool training was fairly pervasive in the CPS--40 percent of men and women reported having received training to improve skills in their present jobs.

2. A number of positive correlations occur between levels of schooling and postschooling work experience. Those with higher levels of schooling are more likely to receive postschooling education and training. And they are more likely to continue to get the kind of company training that yields the highest increase in earnings over the workers' life cycle. Other forms of training, business schools, and technical schools yield lower returns.

3. Formal schooling also played a significant role in getting the respondents' current jobs; this is particularly likely to be the case for workers with postgraduate schooling. However, the postgraduate group is less likely to get other forms of postschool training (i.e., even after going to work they are likely to get most of their training from regular schools). The exception is those with postgraduate schooling in high-tech fields in which regular schools are likely to be inadequate and in which informal training are likely to be more important for this group.

4. The Rand study broadly confirms other findings of a relatively high rate of return to schooling on the order of about 11 percent. As noted below, some thorough, more recent studies show higher returns. The returns to schooling are higher in high-tech industries, in which the effect is two to three times higher for those with advanced degrees than for high-school graduates. Company training has the largest effect on earnings (27 percent); followed by training from "other sources" (13 percent); and OJT (5 percent). The return to schooling is higher when the type of schooling was a significant factor in obtaining a job.

5. The relatively small, though significant, effect of OJT is a surprise. The Rand study also found that except for highly educated professional-technical workers, OJT in other companies does not have much effect either in getting a respondents' present job or in performance on that job. The difference for professional-technical workers, which probably also applies to highly skilled craft workers, undoubtedly is due to the highly specialized nature of their knowledge and skills, which ordinarily are acquired through a combination of on-the-job training and academic or related education.

Longitudinal data on young men (the National Longitudinal Survey) show that earnings rise with the level of formal schooling, especially for those with college and postgraduate degrees in industries experiencing rapid technological change. However, the relationship between post-schooling training and earnings is quadratic and not linear. Training in any given period is associated with a declining annual return in years following the training. Training has two effects: an 11.9 percent increase in the earnings level the first year and a decline in each year since training, declining to zero by the 11th year after training. These findings suggest the importance of continuous training to avoid the decaying effects of training through time.[147] The NLS data also demonstrate the different returns to different kinds of training. Company training has the largest effect (16 percent) followed by training from business and vocational schools (11 percent) and regular schools and "other sources" (8+ percent). Moreover, there is almost no decline in initial earnings from company training but a 10 percent decline for business and vocational school training. The returns to training vary with skill level but the duration effects are greatest for relatively unskilled training and company training.

6. Close positive associations also exist between levels of schooling, training, and the probability of unemployment. The probability of unemployment varies inversely with job tenure, with the greatest risk of unemployment coming during the first five years.

7. It also is noteworthy that the association between technological change and education is positive. This association, and the positive association between earnings, technological change, and education seems to confirm the so-called allocative efficiency of schooling hypothesis.[148] As with earnings, company training has the largest effects in reducing the probability of unemployment.

8. The Rand study underscores the importance of educational equity as well as the positive earnings and employment effects of education and training. Nonwhite men are significantly less likely to get the kind of postschool training that reduces their probability of unemployment and enhances their earnings, even after controlling for levels of schooling and other worker characteristics. However, no significant differences exist between nonwhite and white women, a finding which confirms other studies. Although the Rand study found that about 40 percent of both men and women in the CPS data reported having taken training to improve skills on their present job, the EOPP data showed only 11 percent of the economically disadvantaged had such training. Moreover, a very low proportion of the economically disadvantaged had company training, which, as noted earlier, had the highest positive economic results in terms of low unemployment and high earnings gain. Young white men had a significantly higher probability of receiving any training as well as company training. Moreover, although career women were more likely to receive training than mature men, career women were less likely than either young or mature men to receive the most advantageous company and managerial training. Like the economically disadvantaged, women with intermittent labor market experience received little training.

Unemployment in local labor markets and through time is negatively associated with postschool training. However, there is a procyclical relationship for training of career women and mature men, especially for professional and technical workers, suggesting that employers are likely to train older workers during slack economic periods.

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[147] Note that this suggests an alternative to the standard human capital theory explanation for declining returns to income over time--the human capital becomes obsolete or is forgotten, not just that older workers get less of it.

[148] See Finis Welch, "Effects of Cohort Size on Earnings," *Journal of Political Economy*, October 1979, pp. S65-S97.

While much, unfortunately, remains unknown about the relationship between schooling and postschooling training and work experience, the Rand study provides considerable insight based on what probably is the best data and most sophisticated analysis available. The study confirms the hypothesis that education has large and positive effects for all groups, but especially for white males and, to a lesser extent, career women. This study also provides more precise measures of the effects of different kinds of training than hitherto available.

Finally, a major problem with OJT and learning systems is that almost all of it is done in large firms, while most of the job growth is in smaller companies. Probably 200-300 large companies account for half of the formal training paid for by for-profit companies. Policies therefore need to be developed to make it possible for small companies to meet their education and training needs, probably through associations or learning consortia.

Conclusions on Technical Problems with Education Outcome Studies

These studies demonstrate the strengths and weaknesses of applying standard econometric and social science techniques to education and schooling. The typical textbook approach assumes the output of a production process to be clearly defined, measurable, and determined by a few freely variable inputs which also can be measured. It is assumed further that the production function is known to decisionmakers. One's evaluation of this approach depends upon what use one wishes to make of it. Most of the work in econometrics and neoclassical economic theory could be very useful in clarifying abstract ideas and improving methodological techniques but these studies have very limited value for policy purposes. The assumptions are too restrictive and many important relationships are not measured. Take for example the important question of attempting to determine the impact of the quality of schooling on student performance.[149] Hanushek concludes, after an extensive review of education studies by economists:

> . . .the literature about the relationship between measures of schooling quality and subsequent attainment is ambiguous. The analyses available are often crude empirical forays that are difficult to replicate and to evaluate in a definitive manner. While these studies offer an important perspective on how to observe educational outcomes, they do not currently provide firm guidance that might be used in production function analysis.[150]

Since *quality* is critical to productivity this is an important limitation in the use of these studies for policy purposes. Moreover, ambiguous conclusions from different but equally sophisticated analyses limit their usefulness for policy purposes. Numerous data, measurement, and specification errors also limit the usefulness of these studies to the policymaker. Judgments from people with intimate knowledge of situations often are more reliable than sophisticated econometric studies. Not one of these studies has adequate data for their intended purposes. Most of them use proxies for the necessary variables and rely on data collected for other purposes. Some technical problems are inherent in the techniques used to evaluate the economic impact of eduation. Regression equations, for example, cannot account for causation--they merely establish association. Moreover, regressions usually attribute to the variable to be explained (the dependent variable) residuals that cannot be accounted for by the explanatory (independent) variables--a risky business if all the important causal variables have not been identified or measured. Similarly, many studies use a growth accounting framework, which has serious limitations because the intermediate inputs used to produce education have opportunity costs that usually are not measured or accounted for. Some analysts (who nevertheless find significant returns to education) believe this factor causes growth accounting techniques to overstate the contribution education makes to growth.[151]

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[149] Hanushek, "The Economics of Schooling;" Murnane, "A Review Essay;" and Armor, "Analysis of the School."

[150] Hanushek, "The Economics of Schooling," p. 1152.

Most studies also are very aggregated and do not specify or measure what aspect of education produces improved incomes, productivity, or growth. Orthodox economic theory postulates that incomes are determined by productivity; so it is assumed that measuring incomes measures productivity--a very questionable assumption. Moreover, it ordinarily is assumed that levels of schooling are equal, though studies (like those of Berlin and Sum cited earlier) are now attempting to isolate the relationships between skills, earnings, and other outcomes.

In reality, the most powerful analytical tools cannot disentangle precisely the causal interactions between education, broadly defined, and economic performance because of the complex interactions between the knowledge and skills embodied in people and the production of new knowledge which, in turn, is the source of innovation and technological change. As Mincer put it:

> . . .new knowledge and technical progress are diffused throughout industry and across national boundaries, creating national and worldwide economic growth. If the rate of technical change and its diffusions are complementary with education, the marginal product of education is augmented by the rate of technical progress. At the aggregate level, therefore, education is a factor of production that is both a cause and a consequence of economic growth. Such feedbacks play a large role in the long-term dynamics of the economy. Consequently, estimates of effects of education on economic growth are understated if they confine themselves to the effects on the quality of labor and leave out the effects on technological change and if the effects on the growth of technology are not captured in private returns of those contributing to it.[152]

Similarly, these studies have trouble measuring and specifying the outcomes of schooling. Standardized scores ordinarily are used for this purpose, but these scores may or may not be good indicators of the outcomes we desire. For example, SAT scores might (and apparently do) predict ability to pursue additional education but are not good measures of ability to perform on the job. And all of the studies omit causal variables that have very important implications for student performance, including differences in ability and motivation, physical conditions, and the characteristics of peers in a class or school.

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[151] See Welch and Plant in Dean, *Education and Economic Productivity*

[152] Jacob Mincer, "Comment: Overeducation or Undereducation?" in Dean, *Education and Economic Productivity*, p. 206.

Economic studies likewise often suffer from serious selectivity and specification biases. For example, Coleman, Hoffer, and Kilgore[153] conclude that private schools are better than public schools. We know, however, that this kind of study must deal with two kinds of problems. One is to control for selectivity biases. For example, private school students are more likely to come from homes with high levels of education and income, which we know to be strongly correlated with student performance. The alleged superiority of private schools could therefore be due to this selectivity, not the fact that they were private. The second problem is to be sure that the characteristic being compared (public versus private) is an important variable. The qualities of a private school per se that cause superior performance must also be specified. Other than ideological biases and assertions, most privatization advocates fail to present unambiguous evidence for their conclusions. Some analysts doubt that the Coleman, Hoffer, and Kilgore study adequately does this.[154] The main point is not that the private school students do not have superior performance on standardized tests. The point is that these outcomes probably are not due even mainly to whether or not schools are public or private. In other words, if studies adequately account for other variables, attending public or private schools probably is not a very important factor in explaining student performance.

Other complications are created by the fact that despite the decentralization of schools in the United States, much standardization (i.e., "systems") can minimize differences and nullify results. For example, teachers who really do have superior skills may not make a difference in outcomes for their students because of the system within which they operate. If, for example, curricula, class sizes, tests, etc. are standardized, sufficient variation will not occur in the universe to really test the effects of, say, class size on performance. Moreover, if school policy is to assign poor or unruly students to small classes, a test for class size will yield false outcomes.

Economic studies often assume motives and incentives that may not be present in school systems. Private schools, for example, may actually be motivated and have incentives to improve student SAT scores, but few public school systems are so motivated. Public schools' main motive probably is to deliver educational services to students, believing that there is no one good measure of outcomes except meeting the conditions for graduation. Any system has incentives that may be either explicit or implicit. The policy challenge is to be sure the incentives and motivations produce the outcomes desired by policymakers. But the main point here is to note that problems are created when studies assume and test for motives that do not exist.

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[153] James S. Coleman, Thomas Hoffer and Sally Kilgore, *Public, Catholic, and Private Schools Compared* (New York: Basic Books, 1982).

[154] Arthur S. Goldberger and Glen C. Cain, "The Causal Analysis of Cognitive Outcomes in the Coleman, Hoffer, and Kilgore Report," *Sociology Education*, April-July 1982, pp. 103-122; Richard J. Murnane, "A Review Essay--Comparisons of Public and Private Schools: Lessons from the Uproar," *Journal of Human Resources*, Spring 1984, pp. 263-77.

Another common logical error about systems is to assume that a finding about an existing system is a principle that applies to any system. For example, the finding that expenditures per pupil or class size on the average cannot be demonstrated to make a difference in an existing system, which is what econometric studies do, tells us nothing about the effects of class sizes or expenditures in a specific school system or one we may create in the future. Policymakers usually must change systems that are not achieving desired outcomes. If the incentives, beliefs, and procedures within a system are deeply entrenched, marginal change and one-factor (i.e., class size, increased teacher pay) interventions are not likely to make much difference. Testing for these single factors are unlikely to reveal much.

From a policy perspective, outcomes that originate outside the system should not be attributed to a school system, or particular aspects of a system. Numerous examples of this problem are available. For example, declining SAT scores during the late 1960s and early 1970s were commonly assumed to prove that the schools were deteriorating. In the first place, as noted earlier, correlations prove nothing--they merely demonstrate (usually rough) average associations between numbers. Many other factors other than what was going on in the schools (employment, family structures, characteristics of people taking the tests, etc.) can and probably do account for the declining SAT scores. Our present educational systems probably reflect the society and the economy more than they shape it. Indeed, a major argument about educational reform is that both the outcomes of schooling and its relative importance (i.e, impacts) must be changed if we are to have a world-class economy. What this means, of course, is trying to determine the outcomes of schooling that really are desired by parents, students, and policymakers and developing a system that will achieve these outcomes as efficiently as possible.

The foregoing is not meant to imply that economic and social science studies are useless or that we must take an agnostic approach to the factors responsible for improving the outcomes of schooling. These studies, if properly constructed, can be extremely useful tools for decisions and understanding, but they should not be decision processes. Moreover, these studies merely constitute partial evidence about requirements to develop a better school system. But the judgments of those with intimate knowledge of a particular system can be more important--if cross examined and subjected to tests for bias. Policy analysts will be well advised to be skeptical and tentative with their conclusions.

CONCLUSIONS

This report is based on the assumption that changes in technology and the structure of the global economy have altered the rules of international economic competition for Texas and the United States. Texas owes much of its past economic progress to physical resources, especially land, oil, and gas. Agriculture and energy will remain important industries, but like manufacturing--another historic economic mainstay--they will become much more knowledge intensive. Similarly, America's past prosperity was based mainly on an extraordinary abundance of natural resources; a large, growing, and protected internal market; favorable access to world capital markets; the unique combination of free institutions and people who were able to use the world's most advanced technology; and pioneering work in the development of mass production systems. During the first half of the twentieth century, the mass production system was stabilized by oligopolistic pricing arrangements. When this system sputtered and appeared to fail during the 1930s, it was resuscitated by Keynesian economic policies, which injected public funds into the system to compensate for the tendency of production to outrun private demand. These policies helped usher in the longest sustained period of equitably shared prosperity in our history.

The internationalization of the economy has caused the advantages traditionally enjoyed by America and Texas either to have disappeared or to no longer count for as much as they once did. Technology has caused natural resources to be much less important and has made knowledge and skills the keys to improvements in productivity, living standards, and national power. And the internationalization of economies has eliminated our global isolation and made it necessary for individuals, businesses, and institutions to be more competitive. Our choices, moreover, have become increasingly clear: we can become competitive by reducing our standard of living or by developing and using leading-edge technologies. The development and use of leading-edge technologies, in turn, require a work force with very different and higher-order thinking and communication skills than traditionally taught by America's schools. If we want to be a high-wage, full-employment economy, the evidence is very strong that we must develop very different learning systems. I use *learning systems* instead of schools because school reform is a necessary but not sufficient condition for a world-class economy. We must also have more efficient and extensive adult learning systems because three-fourths of the work force of the U.S. and Texas for the rest of this century already are on the job. Unless we give greater attention to upgrading the skills and knowledge of people who already are out of school, we are not likely to meet the economic challenges we face in the next 10 to 15 years, when our fate is likely to be determined. Throughout most of our history, improvements in productivity have been relatively easy. We have been able to get by with an educated elite, with most workers supplying mainly brawn. If my analysis is correct, and I naturally think it is, we will now have to think for a living. Americans historically have valued schooling but not education. We now have to value education and intellectual activity.

In order to meet this challenge, we must give much greater attention to improving the productivity of schools and other learning systems. This is so because of the magnitude of the challenge we face: we must bring almost all students up to a level that no more than a third have ever met before. The only way to even approximate this challenge is to make monumental improvements in educational productivity. The required changes are not likely to be achieved by simply adding resources to the present system--we must make fundamental changes in the structure of education institutions.

Some of these fundamental changes already are underway--though they have been small relative to what is required. It is particularly important to greatly improve the status, remuneration, and responsibilities of teachers, the key agents of any reform process. Similarly, world-class schools, like world-class companies, need to develop modern production systems. Indeed, we have noted that schools modeled their systems after the scientific management styles developed in the U.S. during the late 19th and early 20th centuries. This system was authoritarian and attempted to fragment and standardize tasks. In the schools this meant carefully prescribed teaching methods, detailed regulations, and close supervision of teachers. Because they were more easily controlled and could be paid less than men, young women were hired, many of whom had only high-school educations.

As was the case with companies, some of these Tayloristic practices are giving way to more participative systems. In part these changes are dictated by higher levels of education by workers and teachers, but other forces also are at work.

1. Tension always exists between the democratic ideals taught in the schools and the paternalism of the school and the work place. It was hard for workers to be treated like adults in the polity and society and like children on the job, though until the 19th amendment to the U.S. Constitution, women often were treated like children inside the school and in the polity and society.

2. Since a more competitive world economy emphasizes flexibility, creativity and quality, participative work styles have come to be accepted as a precondition for achieving these conditions. Despite these changes, American classrooms and work places still bear heavy Tayloristic marks. In fact, because they have not been as directly affected by the more competitive economic environment, schools apparently have changed even less than the factories. For example, Gene E. Maeroff, in a recent study for the Rockefeller Foundation[155] found the typical relationship between teachers on one side and principals and superintendents on the other typically to be adversarial; he concluded that the principal-teacher relationship was so paternalistic and hierarchical that some principals treat teachers "as though they occupied a niche only slightly above that of the students they teach."[156]

The mass production system developed in basic industries during the early part of this century required two classes of workers: (1) an elite professional, technical, and managerial class whose functions were to perform nonroutine services, develop plans, innovate, and give orders; and (2) most workers, who did standardized, repetitive, manual work requiring basic literacy, numeracy and discipline, but little thought. The schools perpetuated this division. Most workers were prepared for the repetitive "grunt" work by the public schools, especially those in large urban areas, while elite schools prepared people for the elite jobs. In the elite schools, classes were relatively small, teachers were well trained, there was more interaction between parents and teachers, the curricula were more diversified, there were greater varieties of teaching methods and options, and an elitist culture emphasized the importance of leadership, learning, and tradition.

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[155] Gene E. Maeroff, *The Empowerment of Teachers: Overcoming the Crisis of Confidence* (New York: Teachers College Press, 1988).

[156] Fred Hechinger, "Closing a Destructive Gap: Bringing Teachers and Principals Together," *The New York Times*, May 25, 1988, p. 22.

A major argument of this report is that intensified international change and the development of information technologies have combined to make it more essential to have workers who think. These developments also require that the schools produce the kinds of skills more suited to the requirements of the modern economy. Moreover, the same skills are required for the choices workers have to make in their daily lives and as citizens of a democratic nation. In short, if we want to be world class (i.e., a high-income, just, prosperous, respected country able to defend and project our values in a dangerous, uncertain, and dynamic world), all students must now have the kind of education previously reserved for the elite; we must democratize education and the schools as well as the work place and the polity.

As the Carnegie Foundation for the Advancement of Teaching emphasized in a 1988 report (*Report Card on School Reform: The Teachers Speak*), school reforms that merely give teachers more responsibilities without more power are likely to make matters worse, not better. As with worker participation, empowerment does not mean eliminating traditional school leaders, because school reforms are not likely to be effective, or even possible, without the active involvement of enlightened superintendents and principals. But effective reforms also will require more empowerment and active involvement by teachers.

As part of the reform process, we also must change the structure of educational institutions in ways that will significantly alter the incentives for students and teachers. The schools must learn the lessons of our most successful and productive enterprises: they must be client centered and performance driven. Clear objectives for students must be established and incentives for educators and administrators to meet those objectives must be created. In addition, decisions must be decentralized to the schools and highly qualified professionals must be held accountable for measured student progress. Unfortunately, at present we have neither clear objectives nor adequate measures of those outcomes. Considerable attention therefore must be given to these matters as the school reform process proceeds.

Reasons developed at length in this paper and the companion papers from the PRP support the conclusion that the most effective use of technology is to decentralize its use to the schools and provide technical assistance to teachers and principals to help them find the most effective processes for their students. Efficient systems will specify outcomes, not processes to achieve those outcomes.

The picture painted above of an efficient school system is more a faith of what could be than a description of what is. These ideal structures do not exist; although the components can be found here and there in individuals schools, and a number of school districts have initiated promising reforms, no school system has yet been able to sustain the kinds of improvements on the necessary scale to justify the conclusion that fundamental changes have been made.

School reform in Texas and in the nation should give high priority to educational equity. There can be no doubt that we cannot be a world-class economy with an educated elite and the present low levels of education of at least half of our work force. Human capital studies make it very clear that people will either be assets or liabilities. Moreover, the demographics for Texas and the United States make it equally obvious that without educational equity we will not have a world-class work force. Fortunately, the evidence provides grounds for optimism that interventions at every stage along the development continuum can yield high personal, social, and fiscal returns, particularly programs like WIC, Head Start, the Job Corps, and their derivative learning systems. Technologies like those developed by the Comprehensive Competencies Program (CCP) have achieved impressive results in overcoming educational deficiencies. Similarly, the evidence with respect to the magnitude and importance of the summer loss phenomenon for low-income students should cause this problem to be given very high priority in any educational reform effort, especially in view of the apparent effectiveness of the experimental STEP summer youth program in more than overcoming this loss in math and greatly reducing it in reading. In addition, clear evidence indicates that children of all social backgrounds, as well as poorly educated adults, can learn as well as anyone and at much higher levels than they do now. Many successful interventions depend heavily on changing attitudes, especially about expectations and who can and cannot learn. We must abandon the elitist myth that education achievement is mainly due to innate ability and not hard work. We also need to get rid of the habit of viewing education as a cost and not an investment.

In a Japanese mystery novel entitled *California Roll*, a Minister of International Trade and Industry (MITI) executive told an American detective: "I will be perfectly honest with you. . .This economic rivalry is not a game to us. Ninety-five percent of our food and raw materials are imported. We do not have the luxury you do to become a second rate agrarian society."[157] If we don't develop world-class learning systems, we will continue down the path to a "second rate agrarian society." Developing these learning systems will not be easy. We undoubtedly will have many failures as we go through the inevitable experimentations required to develop such a system. But we should not fear failure: we should fear the awful judgment of history that we knew what was required to keep America a world-class system, but didn't even try to do it.

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[157] Lewis Branscomb, "Toward a National Policy for Research and Development," Coretch address, Kennedy School of Government, Harvard University, Cambridge, Massachusetts, October 8, 1987.

Appendix A

THE AMERICAN ECONOMY AND EDUCATION IN THE NEXT CENTURY: (EXCERPTED FROM THE CARNEGIE FORUM ADVISORY COUNCIL BRIEFING BOOK, MARCH 1985)

By 'vision' we mean a state of affairs that we want to bring about, not a detailed design. It would be used to guide our selection of activities and shape our priorities in other ways. We would expect it to change over time. We have in mind a vision we share among ourselves; whether we share it with others is an issue we might discuss at our meeting.

This rough, changing guide should prove invaluable. The Forum's resources, though not inconsiderable, are very small in relation to the scope of activity we hope to affect. The trick is to find ways to exert great leverage on the scene with a minimum of resources. The chances of success are low if we are not clear about what we want to achieve over the long haul.

In the section below, we share our own sense of what a desirable state of affairs might be, set at some indeterminant point in the future. It is offered to provoke discussion, and so has a more definite feel than would otherwise be the case. Though it appears to be a photograph, we hope you will see it as a Matisse painting, bold in its outlines, suggestive, an invitation to each of you to invest it with your own views as to where we should want to go.

America's Future: The Economy

We stand now at a point in time some decades beyond 1985. The economy of the United States, stronger than ever, has become a "leading edge" economy on the world scene, its productive capacity founded on the country's ability to create a steady stream of new products and services based on technological advances, which are in turn based on a thriving research and development establishment. A very large fraction of these products and services are sold to people in other countries, at high prices. People are willing to pay these high prices because the innovations they incorporate make them uniquely valuable and well worth the price. These innovations are reflected not just in new final products and services, but also in new forms of energy and new materials, both of which permit much more efficient use of available human and material resources.

America has become a net exporter of goods and services based on state of the art knowledge and very highly skilled labor and a net importer of goods and services based on low cost energy, low cost materials and low cost labor.

Achievement of this high level of output was made possible by heavy investment in the education and training of the workforce and by unprecedented levels of capital investment in the technological infrastructure required to make the most of the high skill levels of the workforce.

Levels of manufacturing output have climbed steadily since 1985. Most of the actual manufacturing is highly automated, but the size of the workforce engaged in highly skilled functions related to manufacturing has not declined greatly, though very few people now work on the factory floor or in the warehouse. Domestic manufacturing operations are now thoroughly integrated with foreign manufacturing and assembly. There is much less emphasis in the U.S. on operations involving long production runs of highly standardized products than in the 20th century, much more on short runs of semi-custom products in relatively small plants using flexible manufacturing systems and highly skilled staff. Though very large firms still dominate the scene, the emphasis on innovation and the lack of comparative advantage for products based on large scale production have led to the widespread development of small, semi-autonomous work groups in firms both large and small.

The remarkably high levels of productivity of this economy were achieved because of several related developments: (1) policies encouraging much higher levels of capital formation, (2) sustained attention to the infrastructure for research, development and innovation, (3) pursuit of U.S. foreign policies designed to strengthen the economies of underdeveloped countries, and (4) critically important, a determined effort to greatly reduce the high levels of structural unemployment and other forms of dependency, which had grown so rapidly at the end of the 20th century that they produced an enormous drag on the economy and threatened political instability.

But it is now clear, in retrospect, that the great improvements in productivity and competitiveness were due as much as anything else to the great changes made toward the end of the 20th century in America's provisions for education and training.

America's Future: Education and Training

Publicly funded day care of high quality is now available to all children who need it through age three, though many young children continue to remain at home, because their parents, who now have much more 'free' time, choose to spend much of that time with their children. Local education authorities now offer regular schooling that begins at age four and goes through age fifteen. Parents can choose among the offerings of many public school agencies, all funded by and responsible to the state in which they reside. Because children from low-income families and minority backgrounds can apply to any public school they want to within a reasonable distance from their homes, all schools now enroll a great diversity of students. Because public schools now compete with one another for students, they have substantial incentives to increase quality, keep costs down, and respond to the expressed needs of their clients. Though states continue to establish minimum curriculum requirements, other strong incentives schools used to have to make their offerings uniform are gone and there is now a much greater diversity of school offerings than there was during the 20th century. Many schools bear little resemblance to those that predominated earlier.

Students in all of these schools are achieving at levels that would have astonished 20th century parents. Fifteen year old students write original essays superior to those produced by earlier college graduates. They are adept at solving problems in statistics and probability, and they mastered the essentials of finite mathematics. They can carry on a solid discussion of the current problems in physics and biology, can employ very sophisticated economic analysis to justify their own views on the economic issues of the day and know something about the technical problems that have to be solved to make tall buildings stand. They know the advantages and disadvantages of different forms of political governance from a historical perspective, and they understand a good deal about the merits of different ways to organize to get work done.

These students are not merely technically competent, however. Their values are based on lively discussion of the values that have characterized other societies in other times. They in turn value the contribution of these who are different from themselves, and see themselves as responsible for making those contributions possible. Their aesthetic sensibilities have been enriched by exposure to the greatest artistic achievements of all time.

They take nothing at face value. They insistently ask why this does or does not work, how we know this is true, whether this goal is worth achieving and how we would know it is. Their skepticism is constructive, however, a quality characteristic of autonomous individual committed to action. They have been equipped to think for a living, to figure out for themselves the answers to questions no one has yet asked, to work with one another when no one is in charge.

All this is made possible in part because career teachers now come from the ranks of the most able college graduates. Their pay, in real terms, is twice that of their 20th century counterparts. They choose what school they want to teach in and are responsible for running the school as they see fit, within broad limits defined by the state, much as doctors and lawyers did in their own 'practices' in the last century. Career teachers make up only about half the ranks of those who teach. The balance comes from recent college graduates who choose teaching to meet their universal service obligation, from people retired in other occupations and from people who teach a day a week in addition to their four day a week job.

Use of retirees, part-timers and young people meeting their universal service obligation is one of the ways in which costs have been reduced to meet the greatly increased cost of the career teaching force. Reduction of the number of years of initial schooling is another. Elimination of many of the costs associated with the administration of large school districts, made possible by instituting schools run by very capable teachers, is still another. Finally, the widespread use of information technology in the schools has relieved human teachers of the burden of some of the more routine aspects of instruction, provided capable teaching assistants in some complex tasks and given students powerful intellectual tools enabling them to undertake studies that were typically done by graduate students in the 20th century.

Although costs per student have increased somewhat since 1985 in real terms, the quality of the graduates has increased enormously. What is most remarkable is that the enormous disparities in achievement characteristic of 20th century students have been all but eliminated. Children from virtually every background now have the skills required for full participation in the nation's economic life. The net result is a very large increase in the productivity of schooling, making possible a commensurate increase in the productivity of the economy which, in turn, produces more than enough additional tax revenue to fund the increased cost of education.

By age 16, then, young people have acquired a better education than the average college graduate had a few generations ago. Between this age and the age of 25, every able bodied man and woman must complete four years of service to the nation, at subsistence pay. There are many ways to fulfil this requirement, including military service, various forms of community service, and teaching. Some discharge their obligations immediately. Others join the paid workforce first, then do so. Still others combine some years of further schooling with some of service.

One of the many advantages derived from this required service is that it provides opportunities for youngsters to exercise responsibility and develop good work habits. Another advantage is to build unity between young people working together for common purposes. The public schools also have become so good that the distinctions between 'public' and 'private' schools have eroded and all young people receive a common perception of the nation's past and a common vision of its future from the school system.

In exchange for service, all students are eligible, when they have completed their tour of duty, for substantial education benefits. These benefits, derived from a variety of revenue sources, including tax free individual education savings accounts, take the form of a lifetime education entitlement, plus a substantial income maintenance allowance. This entitlement, when combined with government grants and employer education benefits, provides a strong incentive for students to invest their own funds in continued education.

The government also provides strong incentives to employers to contribute to their employees' further education and training, and maintains a special pool of funds to supplement the education benefits of workers in declining industries and employees receiving unemployment benefits. In fact, unlike the practice of the 20th century, unemployment compensation has become the last resort for those without jobs, not the first.

It is no longer true, as it was at the end of the 20th century, that college and graduate school is seen as something one does before entering the work force. As the century came to an end, students, facing a steeply rising cost of full time education, and the prospect of continuing education at the expense of their employer if they went to work sooner, chose the latter. Now, many students go to work or universal service right out of school. Much of their further education takes place almost continuously, provided by educational institutions either in or closely connected to their workplace. Education benefits have become such important parts of employee benefit packages that employers negotiate group contracts with suppliers to keep costs down and assure the quality they are after.

Both professional development and vocational education have greatly changed since the close of the 20th century. Both are now predicated on the assumption that the task at the outset is to give students the skills they will need so that they can find out later what they need to know to do their job. This is in contrast to the educator's former preoccupation with pumping students full of all the facts and rote procedures they would ever have to know. In many respects, the old ideal of a liberal education once again informs the curriculum of traditional institutions of higher education, though the specific forms it takes are quite different from any that were widely practiced earlier. There is much more emphasis now on conceptual structure, analytic methods, heuristics, ways of getting the problem straight, tools for gathering and analyzing relevant information and so on. Students get a lot of practice in using sophisticated information technology to assist them in their work. All this is as true for the prospective electronics technician as for the budding doctor.

Much less of the clientele for higher education is made up of people just out of school than used to be the case. Many more college students are well into life. Higher education institutions are now organized to take advantage of that fact, so that much more of the instructional process consists of students learning from one another than used to be the case, and teachers structure courses on the assumption that students often know as much or more about certain aspects of the subject than the professor does.

Distinctions between educational institutions, and the employers' world of government, business and industry have blurred. A great deal of teaching, often of the highest quality, goes on in workplaces. An equally great amount of applications oriented research and development is going on in the leading educational institutions. It is very common for individuals to alternate frequently between staff and faculty roles in educational institutions and other roles in firms and governments. The number of companies giving degrees has increased from only about 18 'pioneers' in the 1980s to several hundred, many of which rival the most prestigious universities, especially in technical subjects. Because learning has become the most important workplace activity, companies have undertaken research on learning that has greatly improved our knowledge and formed the basis for remarkable innovations in learning technology.

Many local 'higher' educational institutions have no permanent faculty and few classrooms, seeing their jobs as connecting people who need education and training with instructors, often in firms, and other resources needed to meet their needs. These institutions contract with firms, unions and community groups as specialists in the business of meeting education and training needs as they arise.

The great universities have become the acknowledged powerhouses of the society. More closely connected than ever before with the world of practical application, they are yet independent enough to advance the new ideas and knowledge that drive the advances on which the society depends. Though many people still need to be on the campus of these institutions to accomplish their goals, being on campus is no longer essential for participation in the life of the university, thanks to information technology. These great institutions are, in all important respects, spread throughout the world by communications links that have turned them into vast extended intellectual communities whose participants carry on lives embedded in many other institutions as well as the university itself. Considerably expanded investment in the great universities has been more than justified by the much greater impact on society that has occurred, at least in part, as a result of the extended reach of the institution. As in the case of the economy generally, careful attention to the computer and communications infrastructure has made it possible to achieve great gains in education productivity.

This interpretation of institutional lives and roles makes it easy and natural for people everywhere to learn constantly. Researchers are constantly prodded innovators in firms to explain anomalous behavior. People in firms are closely linked to sources of new ideas and knowledge. Educational institutions, many of them free of the need to find students for teachers of outdated subjects or to fill conventional classrooms, have strong incentives to meet swiftly changing needs wherever they might arise.

Visitors to the U.S. are impressed by the quality, scope and vitality of education, by the high value placed on intellectual achievement throughout the society and by the high motivation for educational achievement among all segments of the population, much as visitors to Japan were in the latter half of the 20th century.

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COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, U.S. Department of Education.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.